TESTING THE CONVERGENT VALIDITY OF CONTINGENT VALUATION AND TRAVEL COST METHODS FOR VALUING THE RECREATIONAL FISHERIES IN NEW YORK STATE

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ABSTRACT

This research study explores the convergent validity among the contingent valuation (CVM) and travel cost (TCM) methods specifically in the context of recreational fishing, using 1996 New York Freshwater Fishing Survey data. A three-level nested Logit model was applied to the TCM data to estimate the angler day consumer surplus value, which is then compared to estimates obtained from an open-ended CVM question. The daily surplus value estimated by TCM is $41.39, greater than the CVM estimates of $\$30.22\ (95\%\ \mathrm{C.I} = 28.07 - 32.37)$, but the difference was relatively small compared to other studies. These findings are supported by a number of well-cited researches discussed briefly in this study. The anglers fished a total of 18.606 Million days in 1996 hence generating an annual surplus value of $770.14 Million, based on the estimated daily surplus value of travel cost method. The nested-logit model was also tested for sensitivity analysis and found to be stable across additional explanatory variables.

BIOGRAPHICAL SKETCH

Muhammad Jawad Khan is a Lecturer, Department of Economics at BUITEMS, Pakistan. He did his undergrad in Economics from the same school with a distinction as Gold Medalist. He lived all his life in Quetta, a Capital City of one of the less developed provinces of Pakistan. Later on a promising opportunity, Fulbright enabled him to pursue his education at Cornell University.

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TABLE OF CONTENTS

LIST OF FIGURES, CHARTS & GRAPHS

LIST OF TABLES

Chapter 1
Introduction

Recreational or sports fishing is fishing for pleasure or embedded competition just like in any other game as opposed to some profit motive found in commercial fisheries or fulfillment of basic needs in subsistence fishing. Such activities play a significant role in increasing the welfare of people, especially in high-income countries. According to the National Survey of Fishing, Hunting, and Wildlife (2011), 1.809 million anglers (NY residents) participated in recreational fishing and spent about $ 1.999 billion on fishing related equipment. However, the dollar value related to these expenditures fail to provide the surplus value—the maximum willingness to pay over and above the expenditures—that anglers get from their fishing trip experience, nor does it include the indirect or non-use values.

The so-called "economic" contribution of recreational fisheries to local economies can be easily assessed by just looking at the expenditures on equipment and jobs created by this activity and multiplying this by a multiplier value that represents a chain effect in the local economy. But the non-market benefits to the recreationalists that are not reflected in expenditures or captured by any market remain of a crucial importance for natural resource management. A policy maker is always caught by various tradeoffs. These tradeoffs are even more difficult when someone is dealing with the non-marketed goods/benefits. For example, a five star hotel may not be compared with a grove of mangrove trees, until and unless we are aware of the true cost and benefits associated with keeping or removing the mangroves, including those that are marketed and those that are not marketed. In order to facilitate the policy makers to carry out the right decisions, various economic valuation techniques are applied to estimate the monetary worth of non-marketed goods, such as natural resources, based on their direct or indirect uses.

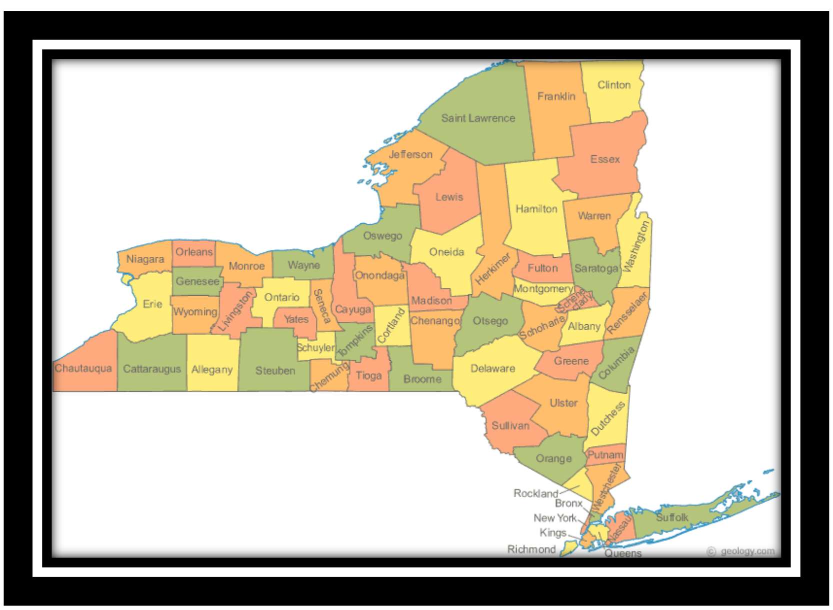
The economic valuation techniques are based on human preferences which are mainly divided into two broad categories; revealed preference and stated preferences approaches. Revealed Preference (RP) Techniques study the change in human behavior in reaction to changes in environmental quality. Stated Preference (SP) Techniques instead directly elicit the value by asking people hypothetical questions through survey methods.

The aim of this study is to estimate the surplus value of New York State recreational fishing while testing for the convergent validity of Contingent Valuation Method (CVM) against Travel Cost Method (TCM), subcategories of stated and revealed preference approaches respectively. TCM and CVM are both officially sanctioned approaches for measuring efficiency benefits for federally financed outdoor recreation investments (Ward & Loomis, 1986).

According to the literature both of these methods assign different values to the same resource, which is problematic. It's a kind of debate across the world whether revealed preference (travel cost) approach gives greater estimates or lesser as compare to stated preference (continent valuation) techniques. A comparative study of 83 studies undertaken by Carson (1996) concludes an average ratio of CVM/RP as 0.89, whereas Clarke (2002) concludes a ratio of CVM/TCM as 1.8. There are plenty of studies supporting the Carson's or Clarke's findings. Rolfe and Dyack (2010), discuss a number of reasons why TCM might be greater than CVM, which include the elicitation format, payment vehicle and bid vector used, the treatment of ‘unsure’ responses, the type of functional form and statistical analysis employed, and the number of sites visited in a single trip. Even the use of an open-ended questionnaire, as compared to dichotomous choice questions, underestimates the consumer surplus Seller et al. (1985). On the other hand Clarke suggests the value of CVM can be greater than TCM due to the fact that CVM also accounts for non-use values like altruism. The objective of this study will be to add new insight to this debate specifically in the context of recreational fishing as well as applying one of the most advanced and rigorous models that were not possible to execute in the past.

The data that is being used for this research study is based on the 1996 New York Statewide Freshwater Fishing Survey having a sample size of about 5,000 anglers, containing decent level of individual and site specific characteristics (see Appendix A for details).

Chart 1: Map of New York (Study Area)[1]



[1] http://geology.com/state-map/new-york.shtml

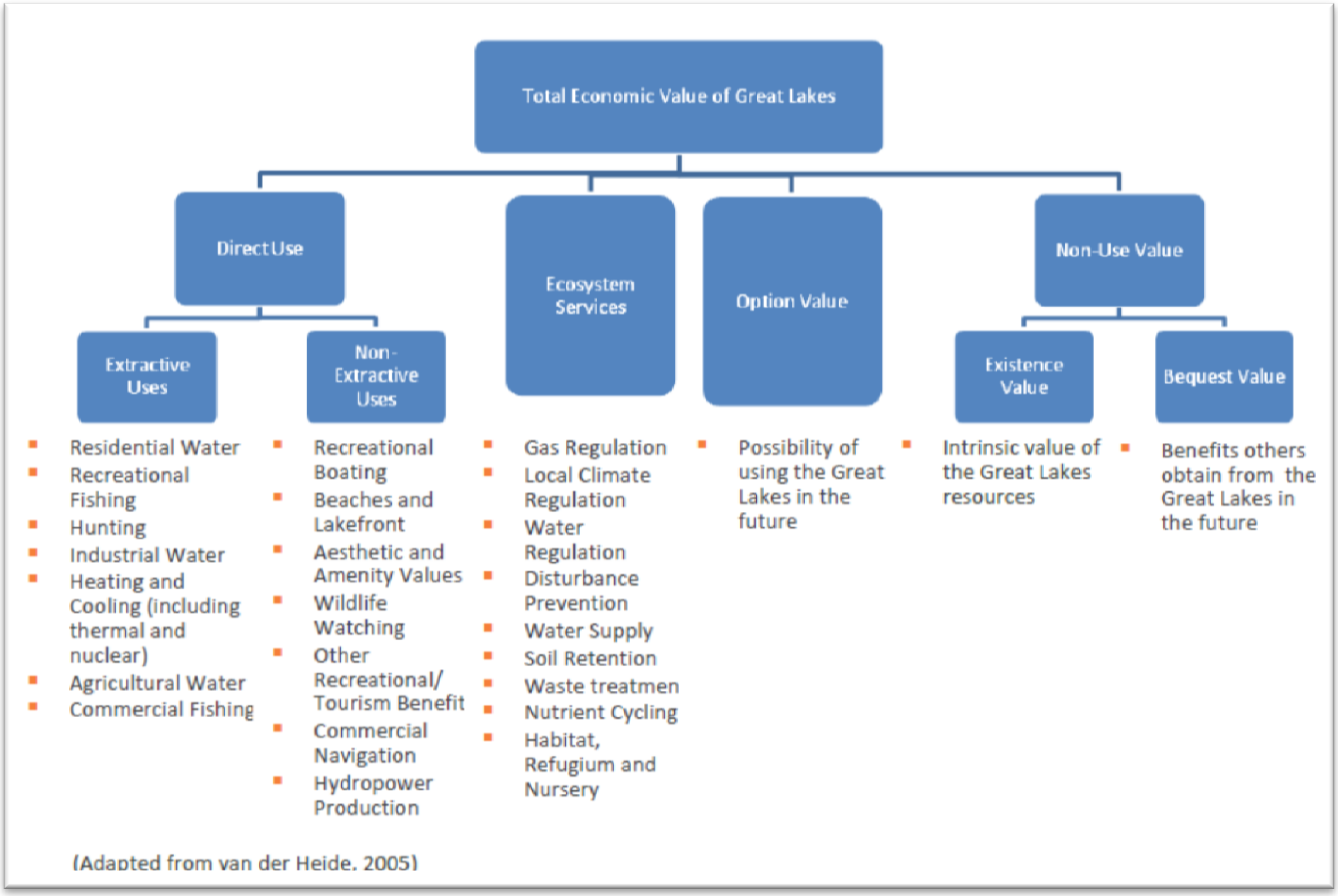
The map represents the geographic area of this study which is New York. The sample set includes anglers from all over NY, composed of 62 counties, fishing at multiple locations.

1.1 Rationale and Bases for Non-Market Valuation

Economic valuation of environmental resources is an effort to assign monetary values to the goods and services provided by those resources, (Daily et al., 1997). There are many who oppose the idea of assigning an economic value to what is often referred as "intangibles", but they should understand the fact that by building bridges or earth quake resistant houses/buildings we are actually valuing human lives. Therefore a proper valuation of natural capital or ecosystems, for which any market doesn't exist, is required.

There are two general, contrasting ways of looking towards environment when deciding its value: anthropocentrism and biocentrism. The fact that economic valuation of natural resources or ecosystems is based on the human uses of a particular resource system means an anthropocentric view of value while biocentric approach includes inherent value to all living things not just human. Figure-1 provides a general overview of all possible uses of Great Lakes, divided into four broad categories i.e. direct use, non-use, option values and ecosystem service. Roughly speaking any natural resource may be divided under the discussed categories for valuation based on its benefits/utility to the humankind.

Figure 1: Total Economic Value of Great Lakes[2]



From an anthropocentric view various economic valuation techniques can be applied to assign a monetary weight, based on each of the uses provided by the resource,.

1.2 Overview of Non-Market Valuation

The economic valuations are mainly based on human preferences which are broadly classified as revealed and stated preferences. In revealed preference the values are estimated from the revealed behavior of people, whereas stated approach elicits values from the stated answers of people to questionnaires or surveys. These preferences are further divided into sub categories which will be discussed in this section.

[2] *Economic Value of Protecting the Great Lakes: Literature Review Report*. Ontario Ministry of the Environment, 2010.

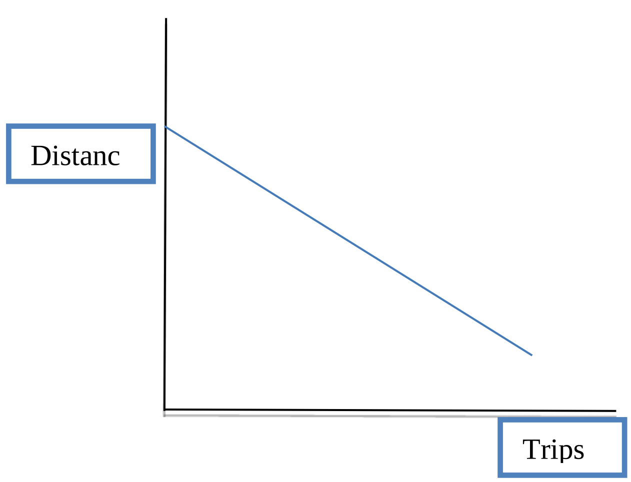
__1.3 Revealed Preference Techniques__

This technique studies the revealed change in behavior due to change in environmental quality. Kahn (1998) in his book "*The economic approach to environmental and natural resources*" divides revealed preference approaches into following categories.

__1.3.1 Travel Cost Method__

The Travel Cost Method is a demand-based model. In this indirect method, a value of some recreational place can be found by analyzing the cost people incur while visiting the place, which also includes the opportunity cost of their time. TCM is one of the two officially sanctioned approaches (the other being CVM-related approaches) for measuring efficiency benefits for federally financed outdoor recreation investments (Ward & Loomis, 1986). The objective of the TCM is to estimate a structural demand equation for a recreation site using the participation rate corresponding to varying travel costs and quality of the site (Casey, 1995). This downward sloping demand curve works just like a conventional demand curve capable of producing consumer surpluses and welfare, showing number of trips on the X axis and the Distance travelled (or cost) on the Y axis.

Graph 1: Travel Cost Demand Schedule



Graph-1: Considering travel cost directly proportional to distance travelled to the site: as distance to the site increases, fewer trips will be taken to that site.

In 1947 Harold Hotelling suggested a demand-based model for measuring recreational benefits in response to an inquiry by the director of the National Park system. He envisioned a set of concentric zones around the recreation area. Taking a representative value of travel cost from the zone to the recreational site as a proxy for price for each zone, with the number of per capita visits from each zone as quantity, he argued that an aggregate demand curve for visit could be constructed. About twelve years later, Trice and Wood and Clawson independently implemented the methodology (Font, 2000; Smith & Kaoru, 1990).

In these early applications, the cost from each zone was considered to be constant, and the most distant zone's cost for which there were some visits was used as a maximum willingness to pay to find out the consumer surplus. The early forms of these models also assumed the preferences of all people in a specific zone to be the same. Hence these efforts failed to account for individual-specific characteristics like age, gender, and income or opportunity cost of time.

Travel cost models can be of two general types, Multi-Site TCM or Single-Site TCM. Both methods have certain advantages and weaknesses. The single site is more suitable if a researcher is interested in finding out a value of a specific site to determine the loss that can occur on its closure. Single site models are also appropriate for valuing any quality changes in a specific site, whether it is related to a change in an entry fee or an addition/subtraction of some desirable attribute. But in case of studying quality changes at more than one site, we require a multi-site model or regional model.

Regional or multi-site approaches can be implemented by both travel cost and contingent valuation methods. There are three types of regional models built by TCM and one by CVM. The first form of regional travel cost model pools many sites into one visitation equation. This model was based on the one extended by Vaughan and Russell (1982) and Smith et al. (1983), also known as varying Parameter Approach. A second variant of the regional TCM is the system of demand equations approach Cicchetti et al. (1976). In this approach, a separate demand equation is estimated for each site or each group of similar sites. The first and second models can be estimated using individual's visitation data but they are more commonly implemented by grouping the visitations by county or equi-distant zones. The earliest form of these models couldn't account for individual specific characteristics which could be significant determinants of value. Over time these models have been improved a lot due to the advancement in software packages as well as data availability; now one can easily include individual specific characteristics like income, age, experience, gender and so on. (See chapter 2 for further details)

1.3.2 The Hedonic Method

Product differentiation adds values to the product. This variation in product variety causes variation in its market price. For example a cell phone with a 13 Mega Pixel Camera costs more than phone with an 8 MP Camera, other things being equal. In same way the Hedonic method indirectly estimates the value of environment through its impact on marketed goods. The most common application of hedonic theory involves housing markets - let's suppose two identical houses are located in different locations having all the similar characteristics except for air quality. A house in one location might cost more than an identical house in another because of the difference in air quality. *Ceteris paribus*, the price difference among the two locations is the price premium or the value of clean air. Such revealed variations can be used to value the environmental amenities (Kahn, 1998).

1.4 Stated Preference Techniques

As discussed earlier, in the stated preference approach a person is asked directly some hypothetical questions to elicit the value he/she places to a specific environmental good or service or a change in the quantity or quality of a good or service. This technique has been further divided into the following major categories.

1.4.1 Contingent Valuation

Contingent valuation (CVM) is a survey-based method frequently used for placing monetary values on environmental goods and services not bought and sold in the marketplace. In contrast to revealed preference techniques that can only be used to estimate use values, CVM and other stated preference approaches are regarded as the only feasible methods accounting for non-use (or passive-use or existence value) considerations in an economic analysis. (Carson, 2000)

Suggested initially by Ciracy-Wantrup in 1947, the first CVM application was conducted by Davis in 1963. In a short period of time this technique became the most important method of valuing public goods indirectly.

CVM constructs a hypothetical market for environmental goods and services based on the hypothetical survey questions regarding the preferences or willingness to pay (WTP), these questions can be both open & closed ended.

Kahn (1998) provides an example of a closed ended or dichotomous choice question:

> Water quality in the Tennessee River is adversely affected by problems of contamination from combined sewage outflow. This problem is caused by the connection between storm sewers and sanitary sewers, which causes the sewer system to overflow when there are heavy rains and spill untreated sewage into the Tennessee River. If the storm runoff was handled through a separate system, it would eliminate the spillage of untreated sewage, significantly improving water quality. The water, which is currently too polluted to swim in, would become safe for swimming. Would you be willing to pay an additional $X per year in your sewer and water bill it the money was used to correct this problem? (p.103)

The above question clearly states the problem, its causes and the medium of payment in other words pre and post-policy scenarios. One should be careful in setting up a questionnaire so that there is no confusion regarding the reason that the survey is undertaken. A misunderstanding about the question may lead to wrong answers or values; let's say if researcher is only trying to estimate the value of clean water for drinking purposes but the question fails to clarify the purpose. It is possible that respondent might fill the value of clean water for industrial purposes or may be recreational purposes. In such case the value he will quote will be irrelevant of the specific project. A similar level of attention is required in selecting a payment vehicle. Suppose there is an entry fee for a national park which is considered high by the general public. In a scenario linking some payment to an increased entry fee may get biased answers. CVM and other stated preference techniques have been highly criticized for many reasons like survey design, kind of questions, payment vehicles etc. yet it is the most widely used non-market valuation technique in the world.

The payment involved in contingent valuation can be of two kinds: 1) Willingness to pay (WTP), used when someone is asked to acquire some good or utility; and 2) Willingness to Accept (WTA), used when someone is asked to give up something (Carson, 2000). One of the core issues which need to be addressed is that a significant difference has been observed between the values of WTP and WTA values. Only in mature market settings do WTA and WTP values tend to converge.

According to a psychological perspective introduced by Kahneman and Tversky (1979), people are much more averse to risk than attracted towards equal gain. Therefore, on average, WTP and WTA demonstrate large differences. People tend to weight an increase in income with relatively less marginal utility and vice versa, which implies a steeper utility function for losses in income as compared with gains. Hanemann’s (1991) neoclassical economic-theoretic presentation demonstrates that disparities between WTA and WTP are to be expected when income effects are large and the good in question has few substitutes. In all, it is quite common to expect large estimates for WTA as compared to WTP.

1.4.2 Conjoint Analysis and Rankings

Conjoint Analysis (CJ) uses survey method where a respondent is presented with a set of options. These options are differentiated by a bundle of attributes, including price (Haefele and Loomis 1999). Let’s say a respondent is provided with the hypothetical characteristics of two fishing sites; the characteristics may include water level, kinds of species, scenery and the entry price. The respondent will then be asked to rank the given sites based on his preferences. Obviously the site ranked higher gets higher value as compare to the other sites. These techniques are commonly applied by marketers for carrying out the market research before or after the product launch.

1.5 Thesis overview

As indicated previously, there are two objective of this thesis. The first is to estimate average net benefits per New York State angler for a day of recreational fishing using contemporary multi-site TCM econometric techniques. The second is to compare these estimates with those obtained from an open-ended CVM using same sample. The intent of such a comparison is to add information to the longstanding debate over the convergent validity between methods.

The implementation of these methods is useless if the estimates are not valid. One of the ways to test the validity of estimates is convergent validity. In order to judge the convergence, two theoretically similar economic estimates measured via two different methodologies are compared (Alberini and Kahn, 2009). Convergent validity means that the estimates derived using different methods are similar. The similar results regarding the willingness to pay help policy makers to arrive at the same decision regardless of the method used.

While there are many previous comparisons of CVM and TCM valuation estimates for the same activity, to my knowledge none of these comparisons have used a multisite TCM model for recreational fishing. Hence, this comparison will add a unique perspective to the broad literature on convergent validity between non-market valuation methods.

The thesis is organized as follow. Chapter 2 discusses the literature on comparing TCM and CVM estimate for recreational angling. Chapter 3 provides an overview of the survey methods used to collect the data. Chapter 4 provides a discussion of the travel cost econometric model. The fifth Chapter discusses the results from the models. Finally conclusions of this research are provided in Chapter 6.

Chapter 2

A Review of the Literature Comparing Travel Cost and Contingent Valuation Estimates for Recreational Angling

2.1 History of Travel Cost and Contingent Valuation Methods

Travel Cost Method: In 1949 Hotelling suggested an idea to The Director of National Park Service regarding the valuation of recreational benefits associated with the use of public lands. This idea actually became what is now known as the Travel Cost Method (TCM). Further Clawson (1959) and Knetsch (1963) started adding more dimensions to this method in empirical explorations. Hotelling suggested the travel cost of user from most distant zone can be used to derive consumer surplus, but Clawson and Knetsch made use of complete demand schedules applying the marginalist idea to derive the consumer surplus.

The initial form of single-site, zonal TCM could only derive values for those sites that had large levels of visitation. By 1986, a regional TCM was established, enabling researchers to circumvent limited visitation rates to individual sites by pooling data across many sites. In this method, the value of a site with small sample size can be estimated using data on other relevant sites having trips per capita as a dependent variable and travel cost, demographic variables and site characteristic as explanatory variables.

The most important advantage of regional TCM as compared to single-site zonal TCM is its ability to differentiate the quality level at different sites as opposed to a single site application where measure of quality remains constant. These quality indicators could be catch rates, fishing efforts, remoteness, water quality and so on.

Previous studies also failed to incorporate the value of travel time cost, which has a significant impact on the relationship between trip prices and visitation rates. As indicated by U.S. Water Resource Council (1979, 1983), one-third of the wage can be an appropriate measure of travel time cost. Additionally the single-site model fails to adequately account for the substitution effect where a person can switch the visitation to another site if relative prices or quality changes. Omission of travel cost time and substitution effects may bias the estimates downward and upward respectively.

Later on researchers started applying discrete choice models, largely based on the econometric methods developed by Daniel McFadden, who won the Nobel Prize in 2000. These models have better theoretical and statistical properties, enabling researchers to account for the attributes of the sites visitor went as well as the sites he/she did not choose. This form of estimation successfully accounts for truncation and censored sampling issues and individual specific characteristics. (See Gordon et al. (1973); Cicchetti et al. (1976); Vaughan and Russell (1982); Smith et al. (1983); Sorg and Loomis (1986); Loomis, Sorg and Donnelly (1986); Phaneuf and Smith (2005); Train (2009))

Contingent Valuation Method: The idea of the Contingent Valuation Method (CVM) stems from Ciriacy-Wantrup's (1947) paper, which discussed how surveys could be used to estimate the public's willingness to pay to prevent soil erosion. Later on this idea was empirically implemented by Davis (1963), who assessed the economic value of the recreational activities in the Maine Woods by applying a hypothetical survey technique. The use of CVM increased dramatically after the Reagan Executive Order 12291 in 1981, which encouraged and accepted the economic valuation of non-marketed goods like environment. An extremely important event in the history of CVM was the grounding of the oil tanker Exxon Valdez on March 24, 1989, in the Prince William Sound in the Northern part of the Gulf of Alaska. Following the event, the State of Alaska appointed an interdisciplinary group of scientists to carry out a CVM study in order to estimate the value of loss to the society created by the oil spill over. The State of Alaska study came up with an estimate of 2.8 billion dollars for the loss created by the oil spill (Carson et al., 1992). Exxon also commissioned a group that challenged the reliability of CVM estimates (Diamond and Hausman, 1994). Finally, the National Oceanic and Atmospheric Administration (NOAA) commissioned a group of experts to evaluate the reliability of the use of CVM for valuing the use of natural resources. The panel was composed of Nobel Laureates Kenneth Arrow and Robert Solow as chairmen. They wrote: *"... the Panel concludes that well conducted CVM studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive values."*[3] After this incidence the use of non-market valuation techniques, specifically CVM and TCM, increased dramatically

CVM has evolved substantially over the years since Davis' initial study. Current CVM methods present individuals with a well-defined good and a systematically designed structure of questions across survey respondents, if aggregation is to be done across all respondents. Questionnaires should also be designed to minimize biases like leading or loaded questions. There are three common CVM elicitation methods: closed-ended, open-ended or iterative bidding question

[3] *NOAA, Federal Register, Vol. 58, No. 10, page 4610*

formats. Closed-ended or dichotomous choice formats ask responded to say “Yes” or “No” to a $X amount. Open-ended formats directly elicit the maximum willingness to pay by asking the respondent to report the most they would be willing to pay for a particular policy scenario. Iterative biding (or dichotomous) keep on presenting them with different dollar amount and respondents choose to pick “Yes” option as long as they reach their maximum willingness to pay. Payment cards, in which an individual circles the highest amount that they would pay form an ordered set of values presented all at once to a respondent, have subsequently replaced bidding games because of concerns that the value reported in the bidding games was subject to starting point or anchoring effects on the initial value. To avoid such effects, contemporary payment card methods include a zero or no payment option and a range of values that does not truncate the WTP distribution (see Rowe et al. 1996).

2.2 Literature Review

In order to test the convergence, two theoretically similar economic estimates measured via two different methodologies are compared (Alberini and Kahn, 2009). Convergent validity means that the estimates derived using different methods are similar.

A number of research studies have examined the convergent validity of TCM and CVM methods for estimating non-market goods/services (see for example Clarke (2002), Carson et al. (1996), (Loomis, Creel, & Park, 1991)), Willis (1990), Bishop and Heberlein (1979)). Most famously, Carson et al. (1996) conducted a literature review of 83 studies that compared, matched, stated and revealed preferences for the same good. This study determined that, on average, the overall ratio between CVM and Revealed Preference (RP) methods to be 0.89. Using only the subset of studies that compared TCM and CVM estimates these authors conclude that CVM estimates were 20 percent to 30 percent lower than TCM estimates on average.

However, previous research has not differentiated these comparisons across methods for recreational fisheries. The remainder of this chapter provides a review of accessible studies carried out in recent past in field of recreational fisheries that compare values estimated from TCM and CVM models. The literature is summarized here in chronological order, starting from 1982, and continuing until 2013.

Harris (1983): In this dissertation, Harris used a survey of Colorado State's Fishing license holding anglers to compare economic values estimated using a zonal TCM and iterative bidding CVM. A stratified sample of about 1,500 resident and non-resident license holders were selected for the study, drawn from the population of 1980 license holders. The mail survey had a 40 percent survey response rate.

The zonal TCM was estimated using OLS regression based on two sets of data: one that included full sample size consisting of single and multipurpose trips, and the other for only single purpose trips. The iterative bidding CVM method asked, "Suppose that your share of the costs of the trip to the water body where you fished had been $xxx higher, and the same cost incurred for the use of all waters similar to the water body. Would you still have gone to that water body to fish?" If "yes", would you still have gone to the water body if your costs increased by $xxx + $yyy. If someone checked "NO", then a lower value was asked (i.e $xxx - $yyy). The process was ended by asking the maximum choke price that would bring the respondent's demand down to zero.

The average WTP per trip for the Full Sample was estimated to be \$38.75 (s.e. = 4.03) for the TCM and \$33.45 (s.e. = 4.46) for CVM. Using a bivariate correlation analysis these estimates were not significantly different at the five percent level. For single purpose trips, the mean WTP for the TCM and CVM methods were \$53.03 (s.e. = \$7.27) and \$24.46 (s.e. = \$61.25), respectively, which were judged to be significantly different. Overall, the author concludes that TCM values "were, in general, larger than the CVM WTP" values (p. 138).

Northwest (1984): In a report entitled "Economic Valuation of Potential Losses of Fish Population in the Swan River Drainage" prepared in 1984, Northwest estimated TCM and CVM models for the purpose of facilitating the decision of whether to construct small scale hydroelectric plants. Apart from conventional cost and benefit analysis, this study aimed to value benefits associated with recreational fishing in Swan river, Swan Lake, their tributaries and the expected lost values associated with projected reductions in fish population, which ultimately causes reduction in the quality of sports-fishing. The CVM respondents were randomly drawn from onsite survey to elicit their WTP, Willingness to Sell (WTS) (In this case is just like WTA measure of valuation), and Willingness to Drive (WTD) extra distance to avoid a reduction in fish population of about 25 percent. The mean WTP was \$35 per year for all the 11 sites whereas mean WTS was \$386, but both estimates had wide variances and were not significantly different from zero. Site by site estimates of mean WTP produced significant estimates for eight of 11 sites, while only four sites showed significant estimates for WTS. The significant estimates for WTP varied from \$11 to \$35 and those for WTS ranged from \$25 to \$1,172. The overall mean estimates for

WTD indicated that on average respondents were willing to drive an extra 106 miles to get the original level of fish population. As expected, average WTP estimates were lower than average WTS. But when median WTP and WTS values were compared they were quite close (see Northwest, 1984). Different estimates at mean level were driven by highly skewed responses at the top 10 percent of responses.

To compare TCM and CVM estimates, the author used two methods of revealed preference approach; zonal TCM and hedonic TCM. Unfortunately the results varied a lot between stated to revealed preference methods. The aggregated estimate for the ZTCM was $78,800 whereas for the CVM WTP approach it was $271,000. Therefore the study failed to conclude any convergence among the two methods, and pointed to the result that CVM values exceed those of TCM.

Donnelly, Loomis and Sorg (1985): This study estimates the net value of Steelhead fishing in Idaho with special emphasis on the comparison on TCM and CVM techniques.

A regional/zonal form of TCM was applied with trips per capita as the dependent variable and travel cost, fishing site characteristics, measure of substitutes, and demographic characteristics of fisherman as independent covariates. The measure of trips per capita, as opposed to total trips, was used to accommodate for population differences among visitor's origin. A survey of 427 randomly selected anglers was used to elicit contingent values. An iterative bidding game (iterative (ICVM) approach was used to elicit WTP, where the respondents were repeatedly asked if they would be willing to pay successively higher and higher amounts for a trip until their maximum WTP was reached. The iterative CVM method was commonly used in the mid-1980's, but has subsequently been discredited because of evidence of starting point issues. In other words the same individual would tend to give a higher final value if the iterative bidding process started from $50 instead of $25.

For the sample for whom the primary purpose was to fish on the trip taken, the estimated mean CVM value was $31.45 with a 95 percent confidence interval of $25.31 to $37.58. Travel cost estimates were estimated using self-reported travel cost per mile measures as well as average cost per mile estimates obtained from secondary sources such as the American Automobile Association. One third of the median wage rate was used as an opportunity cost of time. The median estimate of $8 wage rate per hour was taken from U.S. department of Labor due to the unavailability of individual-specific wages. They refer to the latter approach as the "standard" travel cost method. The average estimates using standard travel cost values were $19.89 with a 95 percent confidence interval between $15.27 and $23.00. Since the confidence intervals do not overlap, then the two estimates are significantly different at the 5 percent level or higher (Poe et al., 1994). In the case of self-reported travel cost, the estimated value was $27.87 with a 95% confidence interval from $23.12 to $34.80. Because there is substantial overlap between the confidence intervals, it appears that the TCM estimates based on self-reported travel cost were not significantly different from the CVM value, however this criterion does not provide an exact significance test (Poe et al., 1994). As such, the TCM estimates are judged to be equal to or lie below the CVM estimates of mean WTP.

The comparison between TCM and CVM estimates at 11 individual sites was inconsistent due to the fact that the distribution of trips across sites is slightly different in TCM and CVM. But the average value of CVM across all 11 sites was greater than TCM. The authors' explanation of why CVM values are greater than TCM value is as follows: "One reason the overall values for CVM are higher than those for TCM is that CVM values are for the angler's last trip while TCM applies to all trips taken during the season" (p. 12). On this basis it was suggested that the weighted average of all sites may not specifically represent each site. Therefore they argue it is better to use specific site values rather than averages across a number of sites when deciding about specific sites. However, in some cases the samples at individual sites was quite small (e.g. 2 visits).

Wegge, Hanemann and Strand (1986): In a report prepared for the National Coalition for Marine Conservation entitled "An Economic Assessment of Marine Recreational Fishing in Southern California", the authors investigated the economic importance of marine recreational fishing in southern California. This study covers multiple aspects—marketed and non-marketed—of recreational fisheries like job creation, participation rate, mode of fishing by trips, expenditure and so on.

To implement the TCM for recreational fishing, a logit model was used to estimate the probability of participation by specific mode: party/charter boat, rental boat, shore, and private boat fishing. Additionally, the probability of owning or renting a boat was estimated using a logit model, taking into account the variables related to demographic and socioeconomic characteristics. To estimate the trip frequency, semi-logged maximum likelihood regression analyses were used, taking logged number of trips against the travel cost, income and time cost. The analyses also differentiated among those who gave up income for this trip and those who did not. Out of 1,330 respondents, 487 indicated a tradeoff between recreation time and income but the rest faced no tradeoff as such. Therefore two models were estimated: one using the "time cost" and the other being a then more "conventional model" without opportunity cost of time. In recent years, studies have typically adopted the opportunity cost of time approach, in which the shadow cost of travel time is accounted for by multiplying hourly wages by a percentage lying between zero and one.

The TCM estimates for charter/party boat using conventional demand model were \$22 and for the time demand model \$91. Moreover, the estimates for non-boat owners were \$49 and \$185 based on simple demand and time demand model respectively. Following the collection of TCM data, iterative CVM WTP questions were elicited. An example used in the report is as follows: "If the cost of party/charter boat fishing (or whatever the mode) were increased by \$10 per trip, would you stop taking party charter boat trips altogether?" If the respondent answered "No", he was asked: "What if the cost increase was \$20/trip, or \$40/trip, or \$75/trip, etc.?" These questions were repeated four to five times, enough to construct an individual demand curve. CV estimated daily surplus value associated with Rental boat was \$18.25 and for private boat it was \$61 (see Page 50). The CVM value of \$61 was closest to the value \$91, estimated from time demand TCM for private boaters. In the case of rented boats, the values were quite different.

Smith, Desvousges and Fisher (1986): In this study, researchers tried to identify sources of variability in TCM estimates, using a case study of water quality impacts on recreational anglers that fish from boats. Three different TCM versions were estimated. In the first two, the modeling was divided into two stages. The first stage estimates the demand equations for all the given sites and the second stage uses these demand estimates in generalized least squares estimator that further regresses these demand estimates on site characteristics. Because the survey data was collected using onsite sampling method, the data were truncated at a lower bound of zero trips and censored at an upper bound of six trips.

The third version of TCM used in the study was a model using consumer price index to adjust for vehicle travel costs and self-reported wage rates. The estimated demand model was based on the pooling of visits across all the given sites under study, considering as they were a single site.

Lastly CVM estimates were collected to compare with the travel cost estimates. The CVM values were elicited using a single discrete question, a payment card, and an iterative bidding approach with starting values at either \$25 or \$100. Based on the results, only the simple travel cost estimates were comparable with CVM estimates. The value of boat-able game fishing via TCM was \$7.16 and via CVM direct question, payment card, iterative bidding (starting at \$25) and iterative bidding (starting at \$100) was \$21.18, \$30.88, \$4.12, and \$20.13 respectively. The study concludes that the significant variability among the observed estimates is an outcome of slightly changing the estimation methods (e.g. using OLS or GLS) the surplus measure evaluated (e.g. Hicksian surplus vs Marshallian surplus) or the type of value question method used in CVM. Overall, however, it appears that the CVM provided higher WTP estimates than the TCM.

Mitchell and Carson (1986): this study was conducted to analyze the cost and benefits associated with the national water pollution control. They used an open-ended

CVM elicitation format to value the water quality improvement, from boatable to fishable while focusing specifically on such clean level of water which can support livelihood of bass species. The questions were straightforward, directly asking the respondents to report their value for maintaining water quality at a certain level-l "How much would you be willing to pay to keep the nation's freshwater bodies from falling below the boatable (minimum) level where they are now." Annual taxes and higher product prices were proposed as a payment vehicle. A payment card format, anchored on an individual's reported income, was used to elicit values.

The original CVM estimates were compared with the Vaughan and Russell's (1982) study which used the TCM to estimate the value of benefits to fisherman from increased quality of national freshwater, improving all water bodies at a fishable quality level. The overall estimates from the Vaughan and Russell study were in the range of $200-1,200 million, with an estimate of $500 million as the best rough point estimate. Mitchell and Carson came up with an estimate of $490 million using CVM method, which according to them is comparable to aggregated TCM estimates of Vaughan and Russell.

Sorg and Loomis (1986): This study explored the advancement in economic valuation techniques that had been made since Gordon et al. (1973). It uses 1983 survey data on recreational fishing to compare TCM and CVM estimates for convergence.

For the empirical estimation of Idaho state fishery, 1,952 anglers having Idaho State fishing license (State or Non-State) were randomly selected and survey questionnaires were mailed to them. Respondents were asked iterative bidding CVM questions related to Cold Water, Warm Water and Steelhead Fishing. The estimates of CVM for cold and warm water fishing were $22.52 (C.I: $19.95-$25.08) and 16.35 (C.I: $12.92-$21.39) respectively which were found to be lower than TCM estimates of $42.93 (C.I: $38.13-$48.84) and $42.18 (C.I: $35.08-$55.86). But in the case of Steelhead fishing, TCM produced lower estimates of $27.87 (C.I: $23.12 – $34.80) as compared to CVM estimates of $31.45 (C.I: $25.31-$37.57) but they were not significantly different.

Loomis, Sorg and Donnelly (1986): Analyzed the variability in values obtained by alternative TCM approaches and compared TCM value estimates with those obtained through CVM.

The study identifies different scenarios where one method can be preferred over another – let's say if one has a small dataset, it gets harder to apply system of demand equation while a pooled approach of varying parameter performs better. Sometimes a decision is to keep a specific park or replace it with some other form of activity - in such case a single site travel cost model can be a better fit in estimating the benefits related to this specific site. Similarly, hedonic travel cost can be used for measuring the net economic value of some specific characteristics at a given site. Lastly, the discrete choice models could be the best options in many cases but they required detailed datasets, including all the sites one could possibly go to, along with greater expertise in the area. Therefore people preferred using regional TCM or CVM in the period when this study was conducted.

Lastly to empirically compare the results, they used same dataset as used in their previous study Sorg and Loomis (1986). TCM models were estimated in three different ways; one having only single site and other two were 3-site and 51-site regional models. The per-trip estimates were $34.37, $56.15 and $66.64 for 51-site, 3-site and 1-site models respectively. The estimated value of 1-site model was closest to $70.11, estimated value by CV method. Over the 51 sites as a whole, the average CVM per trip value was about 25% lower than the TCM estimates of $34.37.

Duffield and Allen (1988): This research applied the CVM method on a survey data of Montana Trout Fisheries for the purpose of measuring the net economic valuate of trout in 20 Montana Rivers, also measuring the WTP for improved quality of trout fishing experience related to catch number and size. The CVM analysis included both open-ended and dichotomous choice approaches. In the open-ended method, individuals were directly asked "What is the maximum increase in your actual trip cost you would have paid to fish here instead of having to fish elsewhere?" For the dichotomous choice approach individual were asked to repeatedly select "yes" or "no" responses for the listed bids, until their maximum bid was identified.

The analysis for open-ended questions was simple and straight forward, just calculating the mean of the recorded WTP by the respondents. But for dichotomous choice anglers at different rivers were divided into clusters based on their reason for fishing. Therefore the net value of fishery seemed to vary across the clusters. The Logit model was used to measure the probability of "Yes" response based on varying amount of bid and other explanatory variables. During the time period of this study Logit was considered to be a complex model to deal with, therefore people relied more on simpler techniques.

Finally this study compares its estimates of CVM based on 1986 survey data with the TCM estimates carried out (by Duffield, Brooks and Loomis, 1987) based on a 1985 survey data. The value estimates of TCM based on same set of rivers was $122 which was similar to the Logit (dichotomous) mean estimates of $127. In case of an open ended CVM the estimated value was $51. A high value of Pearson Product-moment correlation coefficient of 0.73 and similarly a high value for the nonparametric Spearman's correlation coefficient indicate that the TCM and logit CVM values are highly correlated. Thus they have concluded a strong possibility of convergent validity for their contingent valuation estimates based on logit modeling.

Johnson (1989): This study aimed to find out not just the economic value of fishing but the effects of changes in quality on participation, the value of preserving rare native cutthroat trout, the effects of taste and preferences on value and participation and, the most relevant to my study, the consistency of estimates among CVM and TCM. The study was conducted in the Cache La Poudre River and Blue Mesa Reservoir both situated in Colorado. The data was collected via interviews that took place around the campgrounds and Wild Trout sections, randomly selecting 150 respondents at Cache la Poudre River and 200 at Blue Mesa River. CVM questionnaires were pretested for clarity of the purpose, having two sections - one for recreational value and second for socioeconomic characteristics. The questions asked directly for WTP along with iterative bidding type questions. The site at Blue Mesa confirmed the positive relationship between trip cost and net value as suggested by literature but Cache la Poudre River failed to support this relationship. They also tested the hypothesis of fishing skill level and WTP but failed to accept the hypotheses at Blue Mesa River.

The individual observation approach was used to estimate the TCM. The cost of collecting the data for individual approach is greater than zonal TCM but the estimates are more accurate as compared to zonal averages. The data included individual trips, travel cost, income, substitution, socioeconomic variables, and site quality (catch). Apart from high data cost, the individual observation approach has a disadvantage of not considering the probability of participation as a function of distance. As a result the demand curve estimated by this method seems less elastic. According to some studies the value of zonal cost estimates can be similar to individual observation case when the activity requires specialized equipment and skills, because under such condition the likelihood of participation isn't dependent over distance (Sorg and Loomis, 1984; Walsh et al. 1989b). The number of trips to a given site per year is to be a function of the cost of travel between the origin and the site (out of pocket and time costs of travel), a measure of substitute available to user, Socioeconomic variable, site quality index and the index for tastes and preferences. The following Method was used by the researchers to calculate travel cost including opportunity cost of travel.

> "Opportunity cost of the individual's time per trip. The latter was defined as 0.7 (net wage after taxes) times annual income divided by 250 (it was assumed there are 250 working days per year) times days of travel per trip, defined as miles to the site divided by 320 (the divisor was the product of an assumed 40 miles per hour average speed and an assumed eight hours of travel per day. It was assumed that visitors travel 320 miles per day). Thus, the cost variable included a measure of the opportunity cost of time." (p. 123)

The TCM estimated value at Blue Mesa Reservoir was $33 whereas the CVM value was $19. In case of Cache la Poudre River the TCM and CVM estimates were $21 and $13 respectively. The TCM and CVM estimates at both locations were similar under 95 percent confidence interval approach, although such an approach has since been shown to be biased (Poe et al., 1994). Moreover these estimates were also consistent with all the cold water fishing studies applying same methods during the period 1968-1988.

Comparan et al. (2001): This research sheds light on the interesting issue of the relative benefits generated by recreational fisheries for people and local economies in comparison to commercial fisheries in Manzanillo, Colima, Mexico. To find out the net economic value of recreational fishing, specifically for sailfish, the authors used both TCM and CVM techniques. There isn't much work done in this field for developing nations. It was a challenging job to identify the people who were currently angling as there isn't any data base available for the purpose. By finding a private club having list of 1,018 recreational fishermen, they carried out surveys and interviewed those who participated in tournaments, but got a very low response rate of 12.3% for the surveys. Such low response could be an outcome of lack of awareness among the people regarding responding to the survey data or mistrust of Govt.'s management policies. According to Hanemann (1991) notes, such a low response rate could be the result of impatience of the recipients, lack of interest, respondent fatigue, or failing to differentiate between junk mail and the survey.

Individual observation based TCM was applied using logged form Ordinary Least Squares (OLS) regression to estimate the model. The model accounted for individual specific characteristics like age or income and time cost of travel. Moreover a dichotomous choice format question of CVM was evaluated via logistic regression. The consumer surplus per fishing day of sailfish in Manazanillo was $39.10, $22.57 and $7.14 estimated by TCM and CVM (Dichotomous Choice and Open-ended) respectively. In this case the TCM provided Marshallian Consumer surplus whereas CVM was based on Hicksian. The differences among the estimates are expected to be small if the income effects are small. Other reasons that could cause TCM to be greater than CVM was that TCM valued complete site as compared to CVM which only measured the value of sailfish experience. The difference within the CVM estimates were expected and supported by relevant empirical research on elicitation formats (e.g., Welsh and Poe, 1998)

Williams & Bettoli (2003): conducted a study on the net economic value of trout fishing opportunities in eight Tennessee tail-waters using TCM and VCM. An onsite survey based study was employed and a zonal travel cost model was calculated by applying a regression analysis. To drop outliers, they eliminated the counties with zonal distances greater than 95 percent of visitation zones. The natural log of per visit per capita was regressed over round trip travel distance to get the first stage demand equation. Subsequently this equation was to estimate the visitation at varying or increasing distances. Trips were estimating at marginal distances till the point where visits rate becomes zero. The sum of these points represented the recreational demand curve. The hourly wage calculated by obtaining the average income from the onsite survey then dividing it by 2080 (40 hours per Week times 52 weeks). Finally the time cost of travel equation can be written as (distance traveled)×(average wage rate times)× (0.25)/(50mph). A rate of \$0.345/miles was adopted from U.S Department of Revenue (2001) for calculating round trip cost.

A Dichotomous approach was used to elicit contingent values. Current and three hypothetical-scenarios were presented to the anglers: 1) increased chance of catching twice the current trout catch: 2) increased chance of catching a trout with larger size: and 3) cancelation of trip due to natural disturbance. Later on, the anglers were asked to respond "Yes" or "No" for repeatedly asked bid amounts. Logistic regression was then used to calculate the probability of occurrence of "Yes" response. While comparing the estimates with TCM, they found out that the CVM estimates were greater than TCM estimates at all the eight sites. TCM estimates ranged from \$7.35/day on the Clinch River to \$17.90/day on the Caney Fork River. For CVM the corresponding values were \$42.27 and \$91.69 respectively.

Such a significant difference could occur due to reasons like there wasn't a real payment involved in CVM, leading to hypothetical questions getting hypothetical answers because respondents did not truly consider their budget constraint that would occur in an actual or real decision making setting. Or may be the difference could be attributed to the fact that a conservative estimate (one-fourth) for wage rate while estimating the opportunity cost of travel.

Loomis (2006): Using survey data of visitations to Snake River in Jackson Hole, Wyoming, this study had two objectives: 1) to explore the difference between single day trips and multiple destination/multipurpose trips using TCM and CVM; and 2) to compare the values derived from TCM and CVM. The multiple day visitation issue has been a longstanding concern in recreational valuation.

The sample includes all recreational activities like fishing from shore, fishing from boat, hiking, jogging etc. Data was collected via onsite survey method, also sending a follow up post card to those who failed to respond. Total of 657 surveys were handed out with a decent response rate of 65%.

Travel cost estimates were obtained using a count data model wherein following a method developed by Parsons and Wilson (1997), a binary variable was used to distinguish multiple day trips from single day trips in a negative binomial model. The estimated coefficient for the multiple day trips was significant and positive. Estimated mean willingness to pay from the single destination trip TCM model was $7.43 (90% C.I. = $5.34 – $12.20). The estimated mean willingness to pay for the multi-destination data was $120.08 (90% C.I. = $84.14 – $250.70). Given that the confidence intervals do not overlap, these value estimates are significantly different at the 10 percent significance level or better. All reported dollar values are for the year 2000.

Estimated mean willingness to pay from the dichotomous choice CVM data was $8.03 (90% C.I. = $6.44-$11.28) and $17.56 (90% C.I. = $11.50-$50.67) for the single and multiple destination trips, respectively. As with the travel cost results, the confidence intervals do not overlap and hence these values are significantly different at the 10 percent level or better.

For the single destination mean willingness to pay values, the contingent valuation confidence interval is a subset of the travel cost interval, and hence the two estimates are not significantly different. However, the confidence intervals for the multi-destination estimates do not overlap. Thus the TCM estimate of mean willingness to pay is significantly different, and higher, than the CVM.

Whitehead (2006): This study aimed at estimating the value of king mackerel bag limit changes using CVM and TCM. The study used the data from Marine Recreational Fishery Statistical Survey (MRFSS) intercept survey (exit survey), which includes information on trips, catch, harvest, and demographic information. On randomly selected 1,000 sites, over 57,000 intercept interviews of recreational anglers were conducted to gather the information on CVM and TCM. Additionally about 10,000 Add-On MRFSS Economic Study (AMES) telephone interviews were conducted with MRFSS intercept respondents. The final data set combined interviews and calls for the study. Interviewees were selected via stratified random sampling; the strata were made on the bases of state, mode, and two month survey waves and allocated according to fishing pressure.

CVM was based on open-ended questions and majority of the respondents showed zero willingness to pay. Therefore the CVM was estimated using a Tobit model for censored data. The willingness to pay to avoid a change in the bag limit was a measure of the marginal effect of change in the bag limit.

According to the economic theory the angler’s utility depends on fishing trips and harvest. The harvest rate then is dependent on the inputs in a household production function which would include capital inputs (e.g. boat or pier fishing), time or fishing efforts, stock size and daily bag limit and the error term. For some people the bag limits don’t matter since they don’t exhaust their limit. Hence the upper limit has no impact on actual harvest. But those who reach the limit will suffer a harvest loss because of reduced and binding bag limits. For the TCM a count model approach to estimate out the WTP using a variant of a Poisson model that relaxes the restrictive equal mean/variance assumption. WTP was a ratio of difference in indirect utility due to change in bag limit divided by marginal utility of income. The final TCM estimates for the annual WTP to avoid the one fish reduction in the bag limit for entire southeast region was $15.42. The corresponding estimate for CVM was a much lower, at $2.24. According to the author the open-ended questions caused a large number of protest responses.

Whitehead et al. (2009): Estimated the economic benefits of Saginaw Bay coastal marsh (SBCM) via TCM and CVM methods. The CVM study applied a provision point mechanism adopted from (Poe et al., 2002), where a hypothetical "Saginaw Bay Coastal Marsh Protection Program" was introduced to respondents and they were asked to pay one time donation of $X amount for Y acres of land to bring under protection. The inclusion of a provision point funding mechanism created a threshold such that if the aggregate collected amount didn't meet the minimum required amount level the amount would be returned to the participants. If instead total contribution exceeds the minimum funding amount the collected funds in excess of this amount would be used to provide additional educational sites and public access at SBCM. Respondents were randomly provided one of the donation amount in dollars starting from $25, $50, $75, $100, $150 and $200. They had the choice to select "yes", "no" or "don't know" where "don't know" was also considered as no response to get the conservative estimates. To get maximum response to the mailed survey a cash prize of $1000 was announced to be distributed among randomly picked winners. The overall response rate was 22%, making a sample size of 254 for license holders.

A site-choice random utility model (RUM) was used to estimate the TCM. According to RUM theory an individual chooses a site based on distance, trip cost, and site characteristics among various options. Therefore individual will choose a site that gives him maximum utility in comparison to other site in the angler's choice set. The modeling of site selection among various alternatives is random since only the recreationist knows the ranking and utility of each site. The model was estimated in the same manner as their previous study, Whitehead (2006) I discussed earlier. The round trip distance was priced at $0.37 per mile for time-cost, one third of the wage rate was used with the assumed driving speed of 60 miles per hours.

According to final estimates the mean willingness to pay to protect an additional acre of wetland estimated by TCM was $102 whereas the value estimated by CVM was $32.67. Some of the explanations provided by author for such a big difference were following: a) the adjustment of "don't know" answer as "no" answer; b) the donation payment vehicle could've caused free rider biased; c) the value of TCM could be upward bias since conditional logit assumes IIA; d) using wetlands acreage instead of marsh acreage could also affect the estimates.

Rolfe and Dyack (2010): This study uses the TCM and the CVM to estimate the recreational value of the Murray River in Australia. The main purpose of this study is to explore the reasons behind the CVM estimates being lower TCM. The paper discusses the two basic variants of TCM, the zonal and the individual choice model. According to Ward and Beal 2000, it is better to use a zonal approach is if the visitation rate to some site is low. The individual choice model is appropriate when the opposite is true. The study uses individual travel cost models based trips taken during a two year time period to capture more variation in the visitation rate. Furthermore, the TCM was estimated using negative binomial models and truncated forms to account for over dispersion and endogenous stratification—on-site sampling leads to overrepresentation of frequent visitors. While estimating travel cost they dealt with multipurpose trips in an interesting way. Only the one-way cost was included for multipurpose trips while two-way cost was only considered for the dedicated trip, a somewhat arbitrary costing decision.

On the other hand the CVM survey included dichotomous choice scenarios, i.e. if the trips had cost you an additional $XX would you have still decided to come? Subsequently the logit model was used to measure the probability of choosing "Yes" for these scenarios. According to the authors, one of the most important reasons for the variation among the estimates are the different decision points relating to data collection and consideration of substitute sites, opportunity for strategic responses, multipurpose trips and so on. TCM and CVM estimates are highly influenced by the framing and methodological issues therefore it is hard to identify a single methodological variation that can be used to minimize the differences. For example, just removing "Unsure" responses from CV questions can increase the surplus value by 22 percent, hence reducing the difference among the CVM and TCM estimates. The study failed to show any significant impact on travel cost estimates by changing the wage rate or by excluding the travel time from the analysis. Moreover they observed no correlation between the on-site time and travel cost.

The TCM and CVM estimates were compared at different levels from single destination trips to multiple destination trips and finally with the full sample size. The TCM estimates of $149 (95% C.I. = $113–$210), were greater than CVM estimates of $116 (95% C.I. = $99–$142) for the full sample, but were not significantly different. When compared at single destination level, CVM estimates were greater than TCM and opposite was true for multiple destinations. Overall, however, the results of the study confirm the findings of previous ones that concluded CVM estimates tend to be lower than TCM.

Loomis and Ng (2012): A recent study by Loomis and Ng tried to find out the value of trout fishing in comparison with other fish species, using the onsite survey data of Colorado's stocked public reservoirs in 2009. In order to get more reliable estimates, the analysis were carried out by using both TCM and CVM valuation methods. Since onsite survey omits nonusers, results in higher chance of encountering frequent user, the TCM was estimated using truncated endogenous stratified Poisson (TESP) model. The authors were failed to reject the null hypothesis of no over dispersion in data - moreover results from Akaike's information criterion (AIC) indicated TESP as a better fit model.

On the other hand CVM was estimated via a dichotomous choice Logit model. The benefits estimates for trout (TCM = $191.60 & CVM = $196.48) were more than double as compared to non-trout (TCM = $61.68 & CVM = $73.84) fishing. According to the results there is a possibility of convergent validity among the two estimates based on 90% confidence level.

Conclusion: out of total of 18 studies that I discussed here, 12 of them concludes that on average TCM estimates tend to be greater than CVM. Only 5 of them prove the opposite. Surprisingly the CVM/TCM ratio is 1.08 which indicates that CVM estimates are on average greater than TCM. However, this average ratio so not significantly different from unity, suggesting that the null hypothesis of convergence cannot be rejected. Such a ratio is an outcome of two of the studies by Williams & Bettoli (2003) and Northwest (1984). In these two studies the gap among the estimates is huge; CV values are significantly greater than TC, making a CV/TC ratio of 5.44 and 3.44 respectively. If we remove them as outliers the overall ratio drops down to 0.75. The details are listed in Table-1 and Chart-2.

Table 1: Comparison between TCM and CVM Estimates

S/N	Source	Single or Multiple Sites	CVM	TCM	CVM Value in Dollars	TCM Value in Dollars	Reject/ Accept	CVM/TCM Ratio
1	Harris (1983)	MS	Iterative Bidding & Non-Iterative Bidding	Zonal Travel Cost	IB = 33.45 and NIB = 24.46.	FS = 38.75 and SPT = 53.03	N/A	0.63
3	Donnelly, Loomis and Sorg (1985)	SS	Closed ended	Regional Travel Cost	31.45	27.87	Accept	1.13
4	Wegge, Hanemann and Strand (1986)	MS	Iterative Bidding	Logit Model	Charter/ Party Boat = 61	Charter/ Party Boat = 91	N/A	0.67
					Rental Boat = 18.2	Rental Boat = 185	N/A	0.10
5	Smith, Desvousges and Fisher (1986)	MS	Iterative Bidding	OLS, MLE	Direct Question = 21.18, Payment Card = 30.88, Iterative Bidding (a) = 4.12 Iterative Bidding (b) = 20.13 and the Avg of all used methods = 21.578	7.16	N/A	3.01
6	Mitchell & Carson (1986)	MS	Open Ended	Zonal Travel Cost	490 Million	500 Million	Accept	0.98
7	Sorg & Loomis (1986)	SS	Dichotomous	Regional Travel Cost	Cold Water = 22.52, Warm water = 16.35, Steelhead = 31.45	Cold Water = 42.93, Warm water = 42.18, Steelhead = 27.81	Accept	0.68

8	Loomis, sorg and Donnelly (1986)	Both	Dichotomous, Itertive Bidding and Open Ended	Regional Travel Cost and Single Site Travel Cost	70.11	51-site = 34.37, 3-site = 56.15, 1-site = 66.64, Avg = 52.39	N/A	1.34
9	Duffield and Allen 1988	SS	Dichotomous and Open ended	Zonal Travel Cost	122	127	Accepted	0.96
10	Jhonson 1989	SS	Dichotomous and Open ended	Individual Observation Approach	Blue Mesa Reservoir = 19, Poudre River 13	Blue Mesa Reservoir =33, Poudre River 21	Accept	0.60
11	Comparan et al. (2001)	SS	Dichotomous and Open ended	OLS log form	Dichotomous: 22.57 Open Ended: 7.14	39.1	N/A	0.38
13	Williams & Bettoli (2003)	MS	Dichotomous Choice	Zonal Travel Cost	$59.14	$11.05	N/A	5.35
14	Loomis (2006)	SS	Dichotomous	Count Data	8.03	7.43	Accept	1.08
		MS	Dichotomous	Count Data	17.56	120.08	Reject	0.15
15	whitehead (2006)	MS	Open Ended	Count data	2.45	15.42	N/A	0.16
16	whitehead (2009)	MS	Closed Ended	Random Utility Model	32.67	102	N/A	0.32
17	Rolfe Dyack (2010)	SS	Dichotomous	Negative Binomial models (Count Data)	116	149	Accept	0.78
18	Loomis and Ng (2012)	MS	Dichotomous	Truncated endogenous stratified Poisson	Trout = $196.48	Trout = $191.60	N/A	1.03
					Non-Trout = $73.84	Non-Trout = $61.68	N/A	1.20

Table-1 summarizes all the papers that are being discussed in this chapter. It can be concluded from the literature that almost 12 of the 18 studies support TC estimates to be greater than CV and remaining supports the opposite.

Chart 2: CVM/TCM Ratio

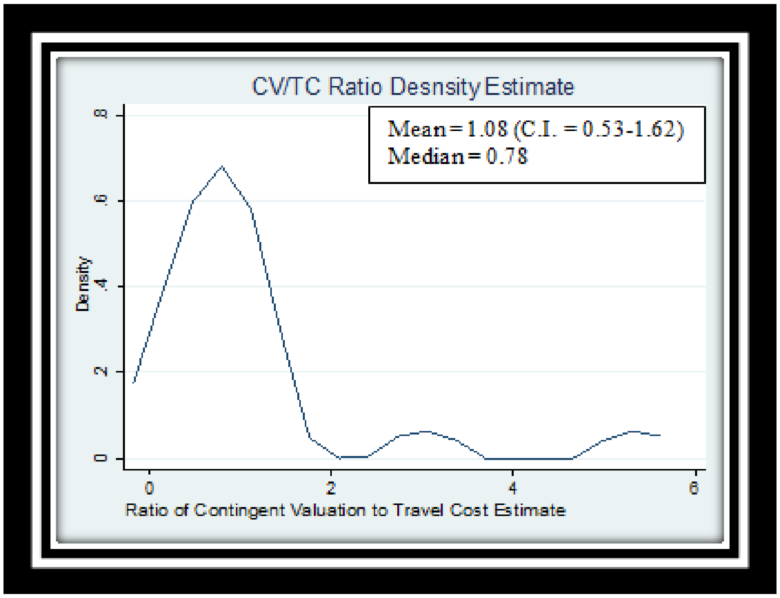


Chart-2 shows the K-density of CV/TC ratios where mean is = 1.08 with the 95% C.I. = 0.53-1.62 and median is 0.78.

Chapter 3

Survey Design and Data

The Survey Data used for this study was collected in January 1997 from the anglers holding New York State fishing licenses for the period starting from 1st October, 1995 to 30th of September, 1996. The data was mainly gathered for the purpose of facilitating a report on anglers' expenditures for the New York State Department of Environmental Conversation. In addition, contingent values of willingness to pay for a fishing day were elicited from about half of the survey respondents. Details of the survey and a detailed evaluation of expenditures are provided in Connelly et al. (1997).

A systematic sample of 17,000 New York State license holding anglers was drawn and mailed survey questionnaires with three follow-up contacts if necessary. The sample was stratified by county of purchase. Out of the 17,000 surveys mailed, 822 were undeliverable and 8,760 returned completed questionnaires. Hence the adjusted response rate is 54.1%. Out of all who failed to respond to the mailed survey, 1,011 anglers were contacted via telephone and considered as representative of non-respondents. According to Brown and Wilkins (1978) and Connelly et al. (1990), the non-responding anglers tend to fish less: therefore a downward weighted mechanism was designed to account for non-response bias (see Appendix B). For authenticity purposes, the data was also tested for recall bias based on its comparison with quarterly telephonic interviews administered quarterly, but no such bias was found in the data.

3.1 Contingent Valuation Data

In order to keep the survey simple, two questionnaires were developed and administered to systematically selected halves of the sample. Both of the questionnaires included the same core set questions regarding the origin, fishing location and socio-demographic characteristics. After eliciting this common information, one version of the survey (administered to about half of the initial sample) focused on eliciting the maximum willingness to pay to take a fishing trip on top of what expenditures the respondents already incurred. These additional contingent valuation questions were similar to those used in the 1988's New York State Wide Angler survey (Connelly et al. 1990)[4].

In the contingent valuation portion of the survey, respondents were asked to recall a specific trip in 1996 and write their per day share of expenditure. Respondents were then asked if they would be willing to pay twice the amount they incurred on this trip. Anglers with "Yes" responses were asked for payment of three times and four times the amount they've already spent and finally they were asked to elicit their maximum willingness to pay for this trip using the following open-ended response format.

> What is the MAXIMUM total amount you would have been willing to pay for the fishing trip before you would have decided not to go?
>
> $ __________ MAXIMUM total cost you would have paid.

[4] In the original analysis conducted in Connnelly et al. (1997) estimation of average willingness to pay followed techniques described in Brown and Hay (1987). In the present analysis it was determined that a simple average of the open-ended contingent valuation responses (less estimated per person expenditures as described in the text) was appropriate for the present analysis.

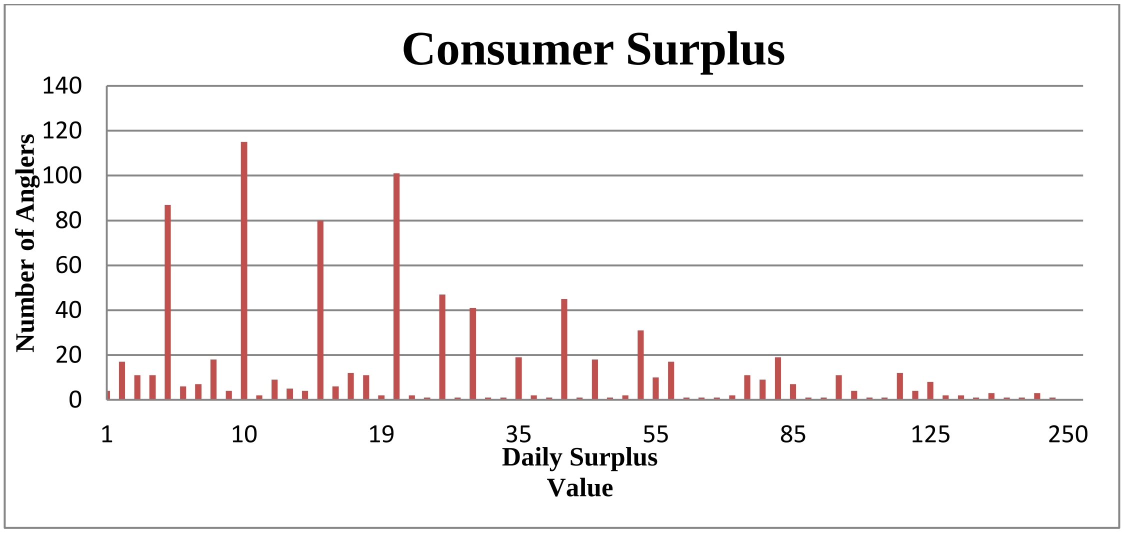
The portion of the trip expenditures reported by the respondent for that trip was subtracted from the maximum willingness to pay to come up with an individual estimate of consumer surplus per trip.

To best parallel the estimated consumer surplus per day values obtained from the travel cost portion of this thesis, only single day trips were retained in this analysis. In addition, the respondents who were not willing to pay more then what they actually paid were considered as protest responses, amounting to 13% of the respondents, were eliminated from the data set[5]. Finally, 4% of the survey responses were eliminated because they were willing to pay more than $264, the maximum cut off limit set in 1988 New York State Wide Angler Survey (Connelly et al. 1990). This corresponds to the $250 (in $1988) cutoff used in Brown and Hay (1987) and adjusted to 1996 dollars using the consumer price index. The data set also merged the Great Lakes Survey results to increase the number of sample size and accuracy of the data. (See Appendix C for details on how data merging was done)

The resulting distribution of consumer surplus values is provided in Chart-3 below. The CVM mean consumer surplus value per day is $30.22, with a 95% confidence interval of $28.07 to $32.37 and the median WTP was $20.

[5] The mean WTP value of a single day trip without removing the protest bias was $30.95 with the median value of $15.

Chart 3: Distribution of Daily Surplus Value



3.2 Travel Cost Data.

The data for the travel cost method was obtained from the information reported in a two-page "Fishing Location and Expense Table" (Question 10 in the Questionnaire in Appendix A) which appeared in both the contingent valuation and non-contingent valuation versions of the survey. This table comprised the centerfold of the questionnaire, and all respondents who fished in the period from January 1 to December 31, 1996 were asked to recall their fishing activities in this period and to complete this table.

The first eight columns, what I refer to as the Core Questions, are drawn from the complete "Fishing Location and Expense Table" provided in Figure-2. Respondents were asked to identify the location, one way mileage, and number of trips and number of days taken to that site for up to eight sites at which they fished. If they fished less than eight sites, they would only provide information on the sites they did visit. An example of "Indian Lake" was provided to help respondents complete this task.

The site and location data, in conjunction with the respondent's home zip code (obtained from the license) and income (Q. 22) of the survey, allowed the calculation of the total cost of travel to the site. Rather than the use of self-reported miles, PC Miler was used to calculate distance from the home zip code to the centroid of the county in which the fishing site was located. As depicted, the number of days taken to each site was also a critical component in the travel cost analysis. Both these data components will be discussed in the next chapter.

Figure 2: Core Questions Used in the TCM Analysis

LOCATION	NAME OF STREAM OR LAKE	COUNTY OR NEAREST POST OFFICE	APPROXIMATE MILESGE FROM YOUR HOME (ONEWAY)	NUMBER OF TRIPS	NUMBER OF DAYS
Example	Indian Lake	Hamilton	90	4	8
1					
2					
3					
4					
5					
6					

7					
8					

Figure-2 contains the core part of the survey that was included in both questionnaires, where respondents were asked to list up to 8 locations that they have visited in a specific year.

3.3 Data Overview

This section briefly discusses the criterion that was used to clean the dataset based on the project requirement.

Table 2: Constructing the Final Data Set

	Remaining Respondents	Remaining Number of Locations Visited
Raw Data	8,757	20,400
Dropped Respondents Who Didn't Fish in 1996	7,620	19,201
Dropped Non-New York Resident	6,178	16,574
Dropped Respondents Who Did not Fill Location and County in the Fishing Location and Expense Table	5,665	15,856
Dropped Respondents With Missing Days &Trips	5,623	15,748
Dropped Respondents with other Missing Values in Socio-Demographic Variables	4,597	12,739
Final	4,597	12,739
Average Destinations Per Person		2.77

Table-2 lists the procedure of data cleaning and its impact on the sample size.

As indicated in Table-2, initially I had a data set with 8,757 respondents visiting a total of 20,400 locations. Unfortunately one can't utilize the information provided by all of the respondents due to missing responses and lack of criteria fulfillment. I had to drop those respondents who did not fish in the year 1996 or if they were not New York residents. Non New Yorkers were excluded because this study focuses only on the fishing benefits to the New York State residents. People having no resident fishing license were also dropped for the same reason. The next step was to drop those who did not fill in the locations, county they fished, days, income or age.

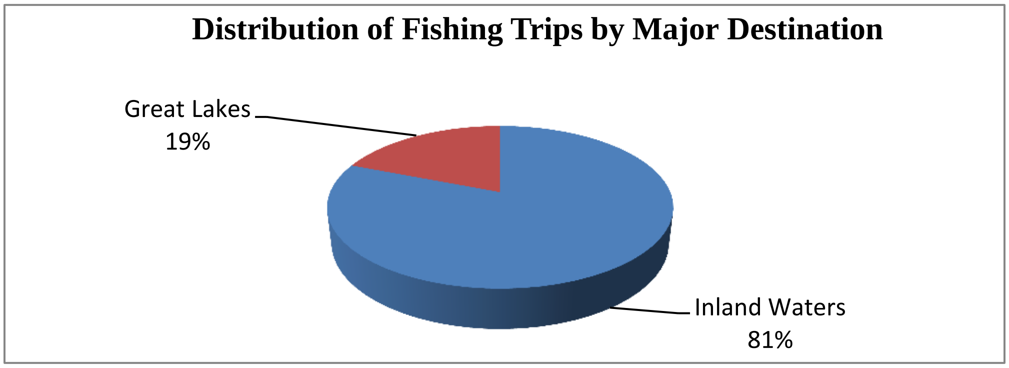
Table-3 provides descriptive statistics for key socio-demographic variables obtained from the fishing license application (e.g. AGE) or responses to the questionnaire (e.g. Annual Income, Experience, Number of Days). Annual income (in thousands of dollars) was taken from interval data for Total Household Income before taxes (Q22). Experience indicates the number of years an individual reports that he or she has fished on a fairly regular basis (at least two days a year). In a year, a person cannot fish more than 365 days, therefore outliers having values greater than 365 were dropped.

Table 3: Descriptive Statistics

	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	4,597	16.00	93.00	43.79	13.30
Annual Income	4,597	9.00	96.00	47.70	24.47
Experience	4,597	0.00	80.00	25.12	15.40
Number Days	4,597	1.00	365.00	25.40	29.27

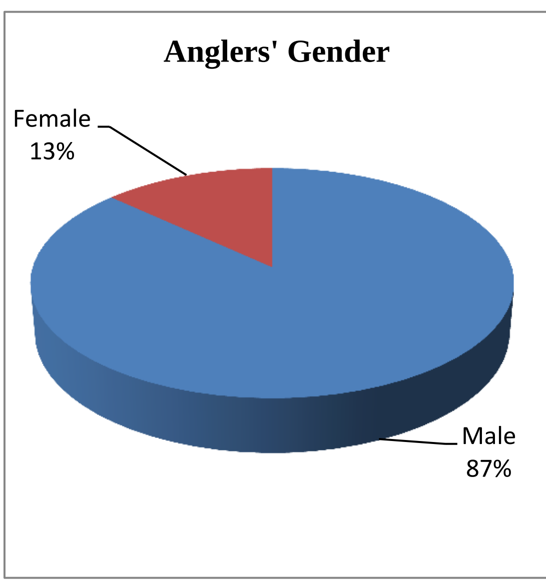
As indicated in Chart-4, almost 81% of the respondents fished at Inland Waters whereas only 19% visited Great lakes. This split in destinations may reflect angler preferences or the fact that the Great lakes may be quite distant from many New Yorkers' homes.

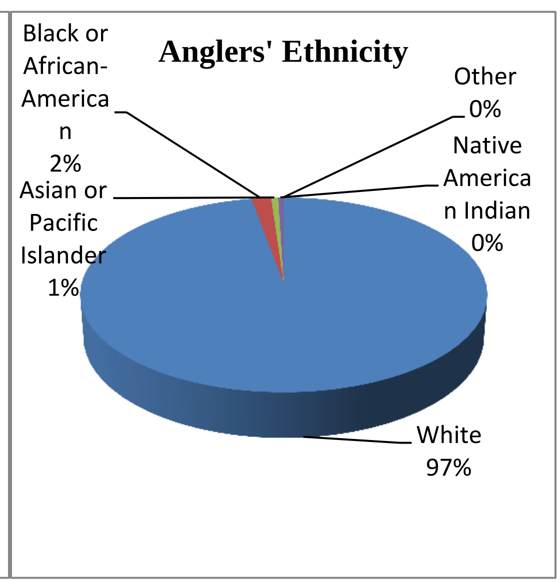
Chart 4: Fishing Region



The charts of gender and ethnicity listed below reveals that the majority of participating anglers were male and belonging to white race. It can be easily concluded that the white race represent a greater proportion of the recreational angling population as compared to any other race living in New York.

Chart 5: Gender **Chart 6: Ethnicity**





Another interesting thing can be seen in Chart 7 is that people who have spent their childhood in a rural area tend to fish more as compared to those living in the cities, whereas chart 8 shows only 27% of the anglers were having a membership of a fishing club.

Chart 7: **Area of Origin**

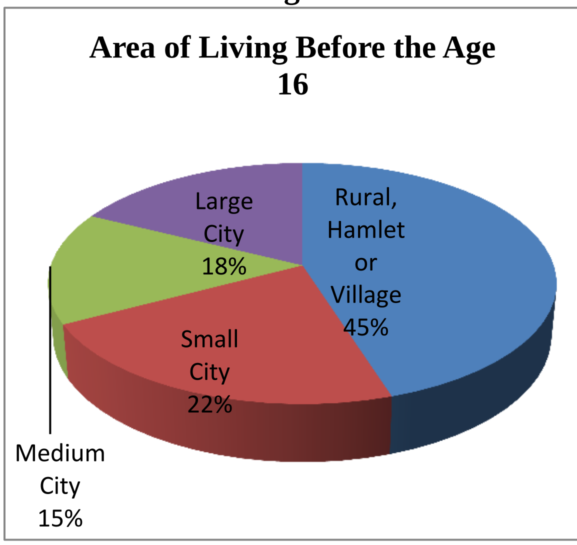
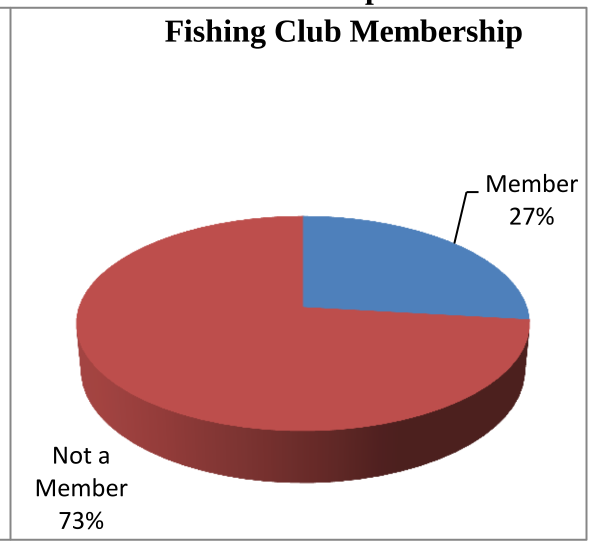


Chart 8: **Club Membership**



The above variables were used in the econometric analysis discussed in the following chapters.

Chapter 4

Model Description

4.1 Discrete Dependent Variables

As discussed previously, Travel Cost Models can be estimated in a variety of ways. Over time, estimation techniques have matured with the spillover effects of knowledge and advance computing techniques, backed with better methods of data collection. Since the initial development of the travel cost method by Hotelling (1949) and Clawson (1959), there has been regular and significant advancement in the application and estimation of travel cost methods from zonal aggregation to regional multisite models and from census-type average characteristics of the fisher population to individual characteristic-based models. As a result, the travel cost approach, which started with many limitations, can be estimated in ways that are consistent with received economic modelling. One of the most notable breakthroughs in travel cost method was the adoption of discrete choice models (Logit, Nested Logit or Probit) in the estimation of site choice.

Individual-level, multisite models like the Logit models have theoretical and statistical properties that enable researchers to analyze the choices fishermen make when faced with a number of site options. This form of estimation successfully accounts for truncation and censored sampling issues. The application of these models can be found in plenty of different fields where the choices involved include travel destination, mode of transportation or purchase decisions, entering labor market or not. Even search engines like Google or Yahoo uses logistic regression to model the probability of relevance based on input criteria provided by users (Varian, 2006).

The choice of buying a good or traveling to a particular fishing site is a discrete outcome that can be modeled using discrete choice econometric techniques derived from Random Utility Modeling (RUM) theory. Just as binary data has a Bernoulli distribution, the multiple alternatives and single outcome based discrete models have a multinomial distribution. Multinomial Logit, Conditional Logit, or Nested Logit models and so on can be used to predict the probabilities related to multinomial distribution. All of these models are executed using Maximum Likelihood Estimation (MLE) methods to estimate the coefficients attached with variables of travel cost, site specific characteristics or individual-specific characteristics.

A limitation of Multinomial and Conditional Logit models is that they apply the strong restriction of Independence of Irrelevant Alternatives (IIA), which restricts the substitution among alternatives or allows only proportional substitution across alternatives. In a condition where a person has hundreds of choices in his choice set, this assumption allows the researcher to pick just a subset of these choices including the one that the person has actually chosen. This assumption also significantly reduces the estimation time and data requirement, especially when the numbers of alternatives are large in number.

According to IIA, the existence or nonexistence of choices outside this subset doesn't matter. Mathematically, the relative probability (P) of choosing alternative i and alternative m is:

$$P_{in} / P_{mn} = e^{V_{in}} / e^{V_{mn}}$$

Thus the P_i/P_m is independent of any other alternative, hence the term IIA While it has advantages, the restrictions underlying the IIA assumption comes with costs in terms of realism. An example is elaborated by the commonly quoted Red Bus/Blue Bus phenomenon in which the commuter initially only has a choice of Car or Blue Bus, each say with a 50 percent probability of being chosen. Suppose that a Red Bus is introduced as a third alternative and that apart from color, it is identical to the Blue Bus. Given these conditions, it is natural to expect that the relative probability of choosing a car over a bus doesn't change even after introducing Red Bus which is a perfect substitute for Blue Bus. Assuming further that the Red Bus and Blue Bus are chosen with the same frequency, the expectation would be that the traveler takes the Car, Blue Bus, and Red bus in the following respective proportions: 1/2, 1/4, and 1/4. Instead, the IIA assumption requires that the ratio in probabilities of choosing a Car or the Blue bus remain constant, and hence the relative probabilities of choosing a Car, Blue Bus and Red Bus would each be one-third, a biased representation of actual choices.

Such unrealistic restrictions IIA assumptions have led researchers to pursue a Nested Logit framework as a better option which partially utilizes the benefits of IIA while taking into account the correlated errors. This model is discussed in the following sections.

4.2 Travel Cost

A recent advancement in the estimation of TCM data, which has enabled researchers to account for individual specific characteristics and uncertainty, is the random utility modeling (RUM) framework in which the utility function of a recreational activity or any activity can be divided in two parts as follows:

$U_{ia} = (V_{ia} + \varepsilon_{ia})$

$V_{ia} = (TC, SQ, ISC)$

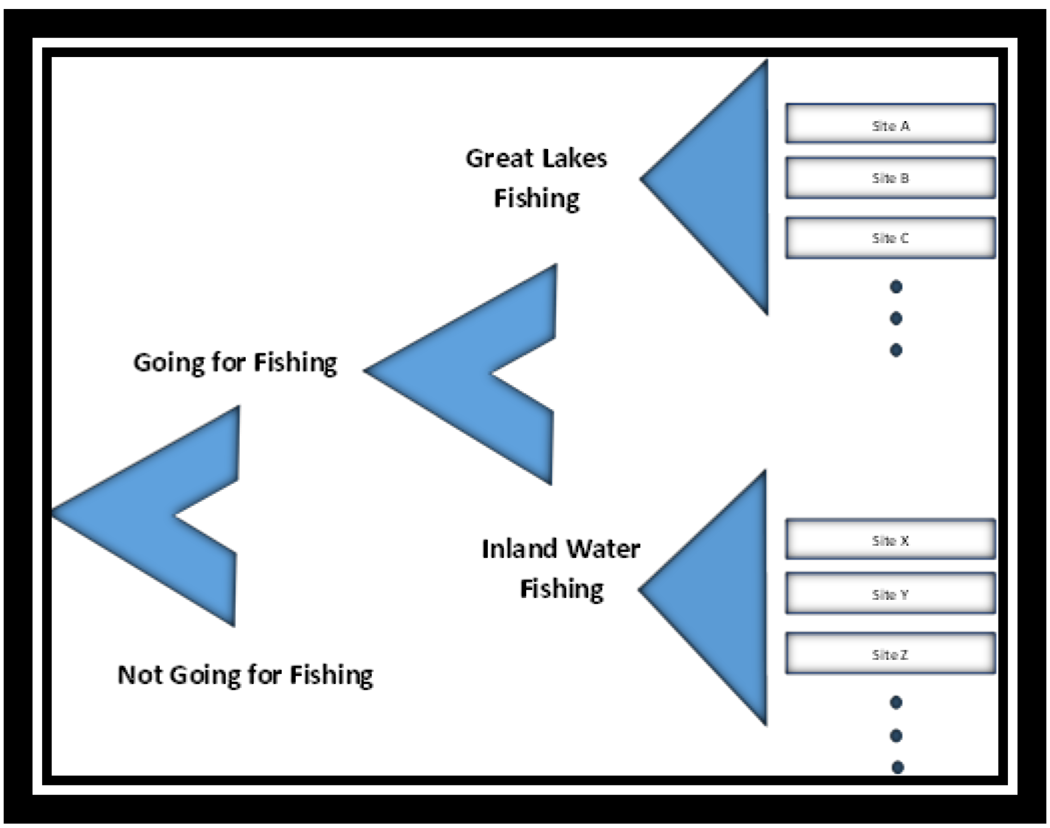
Where:

- U_{ia} is a level of total utility of choosing site i by individual a
- V_{ia} is the utility function observable to the researcher
- Travel Cost (TC) of visitation to a site including fuel cost, wear and tear on vehicles, and one third of income as an opportunity cost of time.
- Site Quality (SQ) represents alternative specific characteristics which can vary from site to site, like habitat score, lake shoreline, lake area, and distance from origin.
- Individual Specific Characteristics (ISC) that include exogenous characteristics of the individual such as age, gender, income and race.
- Finally ε_{ia} is the unobserved random variation in the data.

The model can be executed using a Nested Logit method, which is the member of Generalized Extreme Value family. It was appropriate to apply the Nested Logit because the dataset used for this study includes both Inland Water Fishing and Great Lakes fishing. Hence a three-level nested structure was implemented. The first nest includes the choice of going fishing or not–the participation decision. The second level includes the choice of going for Inland Fishing or Great Lake fishing–the fishing type decision. The final site choice decision represents the choice of selecting a specific site contingent on which nest was chosen at the second level. The unobserved factors are expected to be correlated among the choices within inland water or Great Lakes but across nests.

The Nested Logit model partially relaxes the IIA condition at the top-level nests. But still the site choices within the last nest retains the IIA condition. This implies that the ratio of relative probabilities of any two alternatives in, say, the Great Lake's nest are independent of other choices within the nest whereas the ratio of relative probabilities in upper level nests can depend on characteristics of alternatives from different nests. As such, at these levels of decision making the Nested Logit framework circumvents the Red Bus/Blue Bus problem discussed previously.

Chart 9: Three-Level Nested Logit of Recreational Fisheries



A three-level nested logit model with choice decisions of participation (go fishing/not go fishing), fishing type (Great Lakes/Inland Waters), and site choice (county location).

This nested structure may be most readily understood with the following decomposition of the probability of going Great Lakes fishing at site B ($P_{B,GL,F}$) into the product of three probability functions:

$$P_{B,GL,F} = P_{B|GL(F)}\, P_{GL|F} P_F \qquad (1)$$

- Where: $P_{B|GL(F)}$ indicates the conditional probability of choosing specific site B in Great Lakes (GL) given that the nest of Great Lakes was chosen.
- $P_{GL|F}$ indicates the probability of choosing GL fishing given that the nest of going for fishing has been chosen.
- Finally P_F is the marginal probability of choosing nest F, Going for fishing.

$$P_F = \frac{\exp(W_F + \mu_F IV_F)}{\sum_{n=1}^{N} \exp(W_F + \mu_F\, IV_n)} \qquad (2)$$

$$P_{GL|F} = \frac{\exp(GL\ vars/\mu_F + \frac{\lambda_{GL(F)}}{\mu_F} IV_{GL(F)})}{\sum_{l=1}^{L(F)} \exp(\frac{GL\ vars}{\mu_F} + \frac{\lambda_{l(F)}}{\mu_F} IV_{l(F)})} \qquad (3)$$

$$P_{B|GL(F)} = \frac{\exp(\frac{1}{\lambda_{GL(F)}} v_{i(GL(F))})}{\sum_{j=1}^{J(GL(F))} \exp(\frac{1}{\lambda_{GL(F)}} v_{j(GL(F))})} \qquad (4)$$

$$IV_F = Ln(\sum_{l=1}^{L(F)} exp(\frac{GL\ vars}{\mu_F} + \frac{\lambda_{l(F)}}{\mu_F} IV_{l(F)}))$$

$$IV_{GL(F)} = Ln((\sum_{l=1}^{L(F)} exp(\frac{GL\ vars}{\mu_F} + \frac{\lambda_{l(F)}}{\mu_F} IV_{l(F)}))$$

IV_F and $IV_{GL(F)}$ are the inclusive values or inclusive utility of nest F and sub-nest GL(F), respectively, where IV_F is given by the log of the denominator in Eq. (3) and

$IV_{GL(F)}$ by the log of the denominator in Eq. (4)[6]. Based on this inclusive utility when a person chooses to go for a specific nest, it enters the upper levels of the model as an explanatory variable. This expected utility of choosing nest F is composed of two factors $W_F\ and\ \mu_F IV_F$ where W_F indicates the autonomous utility a person will get, no matter what alternative he chooses in a nest and $\mu_F IV_F$ is the marginal utility of choosing a best alternative in a nest. The scale parameters λ_{GL} provide an indicator of independence among the unobserved portion of utility in the site choice made in each fishing type nest. A lower value of λ, means: less variance; less independence; or equivalently more correlation in the error terms across sites within the nest. Similarly, μ is the scale parameter for the fishing type decision. To be consistent with utility theory, μ should be <=1 and lambda < μ (Hensher et al., 2005). [7] A similar probability structure can be developed for inland waters fishing site choices

[6] Gil-Moltó, M. J., & Hole, A. R. (2004). Tests for the consistency of three-level nested logit models with utility maximization. *Economics Letters, 85*(1), 133-137.
[7] (Train, 2009)

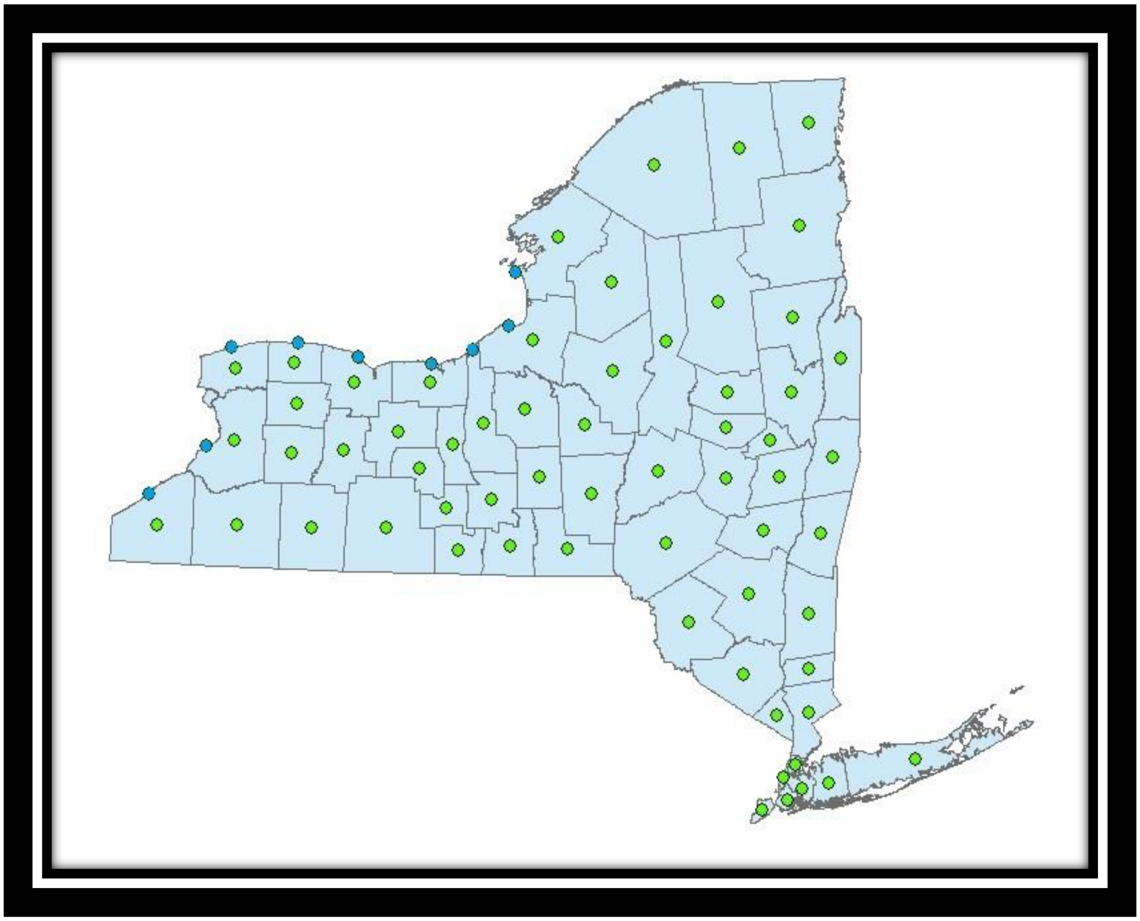
Chapter 5

Results and Discussions

As indicated in the previous chapters, the site-choice travel cost model estimates the probability of visiting a given site from a choice set of many sites. The modeling exercise accounts for site characteristics, individual-specific characteristics, and travel costs. While respondents had the opportunity to indicate the sites that they visited and the mileage to the site, a more "standard" approach, following the terminology used in the Donnelly, Loomis and Sorg (1985) report reviewed in Chapter 2, is to use objective estimates of time and costs. Unfortunately, the sites listed by individuals were not geo-coded, which precluded site-specific calculations of travel costs from the individual respondent's home zip code to the identified fishing site. Instead proxy distances were calculated using the centroid of the county as the location of the fishing destination. The centroids for each county are indicated by green dots in the map below. The blue dots represent the approximate mid-point of the Great Lakes shoreline for those counties that border Lake Erie or Lake Ontario, serving as a site proxy for individual who indicated that the "Name of the Stream or Lake" location as Lake Erie or Lake Ontario. This resulted in 71 distinct freshwater fishing sites in New York State.

To best match the contingent valuation data and to limit the number of site choices in the choice set, only county centroids for inland water fishing and shoreline midpoints for Great Lakes fishing that lie within were included. Based on a criteria used by Parsons and Kealy (1992), all locations/lakes that were 180 miles away from interviewees' home are assumed to be greater than a day trip, therefore it was excluded from the choice set. In our case, the maximum cut off of 180 minutes was selected because 95% of trips were taken below this level of time span.

Chart 10: County and Shoreline Centroids for fishing site locations.



5.1 Description of Variables

The model was estimated based broadly on three categories of independent variables: 1) Travel costs; 2) County-level fishing site specific characteristics; and 3) individual specific characteristics.

5.1.1 Travel Costs

Travel costs are included in the model as a continuous variable representing the sum of three monetary components. Distance from the respondent's home zip code to the county centroid or shoreline midpoint lying within 180 minutes of driving was calculated using PC Miler™ software, and multiplied by 0.46 cost per mile based on American Automobile Association's (AAA)'s average total cost per mile for the year 1996. The PC Miler™software also provided Toll Costs for routes that used toll roads. The third component of travel cost was the opportunity cost of time: PC Miler™ calculated the minutes traveled, which were multiplied by the wage rate per minute (Annual Income/2000 hours per year/60 minutes per hour) and divided by three. Dividing the wage rate by three is a commonly used method of representing the opportunity cost of time (Ready et al. 2012).

It is expected that the estimated coefficient on Travel Cost will be negative. *Ceteris paribus,* the probability of going to a fishing site is inversely related to the cost of traveling to that site.

5.1.2 Site Specific Variables

- Total Shore Length per county, Total Stream length per county and Total Lake area per county: are continuous variables provided by New York State Department of Environmental Conservation (NYSDEC) and calculated by Spink (2014). It is expected that the coefficient on these variables will be positive. That is, the probability of visiting a site in a particular county is positively related to the quantity of water resources in that county.
- Total Great Lake Shoreline per county: a continuous variable adopted from Ready et al. (2012). As above it is expected that the coefficient will be positive.

- Habitat Score: is an index measuring the level of aquatic habitats the scale ranges from 1 to 5, where 1 indicates the highest risk of habitat degradation and 5 vice versa (Ready et al., 2012). The coefficient on this quality variable is expected to be positive.
- Finally the Regional Dummies related to the destinations of anglers' fishing trips were included. A total of nine regions are categorized by the NYSDEC, and therefore eight out of nine dummy variables were included. The excluded region is second region, which is New York City. There are no prior expectations for the sign of these coefficients.

5.1.3 Individual Specific Variables

- Gender**:** a discrete variable where 1indicates a female and 0 as male. There are no a priori expectations for the sign of the coefficient on gender.
- Age: A continuous variable. Based on results from Ready et al. (2012) it is expected that this coefficient will be positive.
- Income: a continuous variable showing how much an angler earns annually. There are no a priori expectations for the sign of the coefficient on income.
- Years of Fishing Experience: a continuous variable likely to be correlated with age. The expectation for this coefficient is likely to be positive, reflecting avidity.
- Fishing Club Member: A discrete dummy variable where 1 represents being a member and 0 the opposite. It is likely that the coefficient on

this variable will be positive, although, as discussed below, there are reasons to be concerned about the endogeneity of fishing membership as an explanatory variable.

- Variables on Background of Anglers: dummy variables were included for those anglers who lived their initial 16 years of life in a rural area, small city or medium city relative to large city. There are no a priori expectations for the sign of the coefficient on these variables although one might expect that respondents with rural backgrounds are likely to be more involved in hunting and fishing.
- Race: a dummy for each major identified race (Black, White, Asian, Native American Indian) was included, relative to the category of "Other" race. There are no a priori expectations for the sign of the coefficient on these variables.

5.2 Estimation Results

A three-level Nested Logit model with choice decisions of participation (go fishing/not go fishing), fishing type (Great Lakes/Inland Waters), and site choice (county location) was estimated with four different sets of independent variables. The results for each model are reported in Table-4.

The first model (Model 1) includes all the basic variables and regional dummies, but excludes the variables "years of fishing experience" and "member of a fishing club". Model 2 includes all the variables from the first model along with the variables of experience and club membership. After including these variables, the estimated coefficient for the Age variable turned negative. This might be due to the fact that the older anglers have greater experience fishing and hence there may be multi-collinearly. The variable of being a fish club member might also be causing the problem of endogeneity as there is the possibility that an angler who buys a membership is a more avid fisherman, which means the dependent variable is explaining some of the variation in membership variable, not accounted in the model. Endogeneity too, may be a problem with experience.

The third model excludes all the regional dummies along with the membership and experience variables. Model 4 is estimated to facilitate comparisons between models estimated for other survey years that do not have as rich of detail on individual socio-economic and other variables. In particular Model 4 corresponds closely to that estimated for Fishing Year 2007, by Elizabeth Spink, including only the demographic characteristics of age, gender and income. A notable difference is that in 2007 data the income variable used correspond to the individual's zip code rather self-reported income.

Table 4: Economic Value of NY State Recreational Fishery

Variables	Model 1	Model 2	Model 3	Model 4
	Coefficients	Coefficients	Coefficients	Coefficients
Travel Cost ($/100)	-1.425***	-1.312***	-1.392***	-1.411***
	(0.018)	(0.018)	(0.017)	(0.018)
Total Inland Water Shoreline per County (mi/100)	0.001	0	0.029***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Great Lakes Shoreline per County (mi/100)	2.058***	1.913***	2.680***	1.989***
	(0.044)	(0.042)	(0.043)	(0.043)
Total Stream Length per County (mi/1,000)	0.005	0.006*	-0.033***	0.005
	(0.003)	(0.003)	(0.002)	(0.003)
Total Lake Area per County (mi^2/100)	0.551***	0.522***	0.561***	0.556***
	(0.014)	(0.014)	(0.013)	(0.014)
Habitat Score	0.152***	0.139***	0.240***	0.147***
	(0.005)	(0.005)	(0.004)	(0.005)
Constant	-4.564***	-4.233***	-4.359***	-4.786***
	(0.048)	(0.045)	(0.04)	(0.038)
Female	0.0591***	0.109***	0.0413***	0.048***
	(0.01)	(0.01)	(0.01)	(0.01)
Age	0.005***	-0.003***	0.004***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
Income	0.0557***	-0.005	0.080***	0.070***
	(0.015)	(0.015)	(0.015)	(0.015)
Lived in Rural Area (Before the Age of 16)	-0.147***	-0.174***	-0.153***	N/A
	(0.01)	(0.01)	(0.009)	
Lived in Small City (Before the Age of 16)	-0.097***	-0.111***	-0.077***	
	(0.011)	(0.011)	(0.011)	
Lived in Medium City (Before the Age of 16)	-0.094***	-0.079***	-0.089***	
	(0.012)	(0.012)	(0.011)	
White	-0.225***	-0.378***	-0.051	
	(0.03)	(0.028)	(0.032)	

Black	-0.401***	-0.497***	-0.236***	
	(0.04)	(0.039)	(0.042)	
Asian	-0.083	-0.201***	0.279***	
	(0.051)	(0.051)	(0.05)	
Native American Indian	-0.231***	-0.324***	0.157***	N/A
	(0.054)	(0.054)	(0.054)	
Member of Fishing Club	N/A	0.246***	N/A	
		(-0.007)		
Years of Fishing Experience		0.012***		
		(0)		
Great Lakes Dummy	0.0921***	0.082***	0.007	0.131***
	(0.013)	(0.012)	(0.011)	(0.012)
Mu (μ)	0.583***	0.528***	0.531***	0.584***
	(0.005)	(0.005)	(0.005)	(0.005)
Lambda (λ) Inland	0.400***	0.367	0.393***	0.396***
	(0.005)	(0.005)	(0.005)	(0.005)
Lambda (λ) Great Lakes	0.301***	0.277***	0.322***	0.298***
	(0.005)	(0.005)	(0.004)	(0.005)
Region 1 Origin	0.01	0.162***		0.924***
	(0.031)	(0.03)		(0.022)
Region 3 Origin	-0.241***	-0.236***		1.116***
	(0.024)	(0.025)		(0.023)
Region 4 Origin	-0.535***	-0.476***		1.001***
	(0.027)	(0.027)		(0.024)
Region 5 Origin	-0.573***	-0.508***		1.343***
	(0.027)	(0.0277)		(0.027)
Region 6 Origin	-0.672***	-0.650***		1.219***
	(0.027)	(0.0277)	N/A	(0.026)
Region 7 Origin	-0.566***	-0.495***		1.038***
	(0.026)	(0.026)		(0.025)
Region 8 Origin	-0.471***	-0.390***		0.846***
	(0.026)	(0.026)		(0.024)

Region 9 Origin	-0.473***	-0.419***		0.915***
	(0.027)	(0.027)		(0.025)
Region 1 Destination	0.986***	0.814***		0.003
	(0.024)	(0.02)		(0.03)
Region 3 Destination	1.159***	1.025***		-0.3025***
	(0.024)	(0.021)		(0.024)
Region 4 Destination	1.042***	0.924***		-0.607***
	(0.025)	(0.022)		0.026
Region 5 Destination	1.388***	1.244***		-0.638***
	(0.085)	(0.026)		(0.027)
Region 6 Destination	1.261***	1.127***		-0.782***
	(0.028)	(0.025)		(0.027)
Region 7 Destination	1.084***	0.961***		-0.631***
	(0.026)	(0.023)		(0.025)
Region 8 Destination	0.887***	0.779***		-0.527***
	(0.025)	(0.022)		(0.025)
Region 9 Destination	0.948***	0.835***		-0.572***
	(0.026)	(0.023)		(0.026)
Log Likelihood at Convergence	-598047.34	-596209.91	-603331.73	-598114.53
Value Per Day	40.92	40.26	38.15	41.39
Number of Anglers	4,597	4,597	4,597	4,597
Number of Destinations	12,749	12,749	12,749	12,749
Note: ***, **, * are significant at 1%, 5%, and 10% respectively, and the values in the Parenthesis are Standard Errors.				

Another issue worth noting is related to the variables of background and race of anglers, in other words, individual specific characteristics. Those anglers who lived their initial 16 years of life in a rural area, small city or medium city tend to fish less. The race variables like White, Black, Asian, or Native American Indian has a negative impact on the probability of visitation.

As discussed in previous chapter, to be consistent with the utility theory, μ should be <=1 and λ < μ. It can be seen in Table-4 that the value of μ in all 4 models is < 1 and the $\lambda\,\text{Great Lakes}, \lambda\,\text{Inland are} < \mu$. These results hold for each of the estimated models.

Despite differences in estimated parameters for Models 1 through 4, the following suggests that the estimated consumer surplus per day is relatively stable across models. The marginal value of a day of recreational fishing is estimated by dividing the participation nest parameter μ by the coefficient on travel cost (Ready et al., 2012). Across the four models, these marginal values of a day of fishing ranged from $38.15 to $41.39.

5.3 Comparison with Contingent Valuation Estimates

In all cases the estimated consumer surplus per day estimates using the travel cost method seem to be higher than the mean estimates from the contingent valuation method.

As reported in Chapter 3, the mean consumer surplus value per day estimated from the contingent valuation data is $30.22, with a 95% confidence interval of $28.07 to $32.37. The values estimated by Travel Cost Method in all four models lie above the upper value of this range.

The anglers fished a total of 18.606 Million days in 1996 hence generating an annual surplus value of $770.141 Million, based on the estimated daily surplus value of travel cost method or $562.303 Million based on Contingent Valuation Method. Based on method, this sector contributes a lot to the welfare of American people but these benefits are not represented in conventional market structure.

Chapter 6

Conclusion and Discussion

It can be concluded from this research that travel cost estimates were greater than the estimates of contingent valuation method, findings were supported by number of key papers including Harris (1983), Wegge, Hanemann and Strand (1986), Mitchell & Carson(1986) Loomis, Sorg and Donnelly (1986), Comparan et al. (2001), Loomis (2006), Whitehead (2006), Whitehead et al. (2009), Rolfe and Dyack (2010). Navrud (2001) conducted a meta-analysis on number of studies dealing with recreational values also concluded travel cost estimates to be greater than contingent valuation. This might occur due to the fact that people tend to discount their willingness to pay as opposed to a real picture revealed from travel cost method or they may fail to understand the real value of natural resource to them when asked. In my case the difference among the two estimates was not that large. Therefore a possibility of convergence may be expected in long run with mature market settings.

For future reference, it would be interesting to combine all the available surveys for New York State's anglers (e.g. 1988, 1996, and 2007) and come up with a single study analyzing the economic behavior of anglers over time. The survey that I used for this study asked not only the days that anglers spent on each location also the trips that they have taken, therefore it can be an interesting area to see the impact of taking the number of trips as opposed to the days.

Appendix

Appendix A: Questionnaire

NEW YORK

FRESHWATER FISHING

SURVEY

1996 NEW YORK STATEWIDE FRESHWATER FISHING SURVEY

Research conducted by

CORNELL UNIVERSITY

Department of Natural Resources

in cooperation with the

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

This study concerns your sport fishing in New York State during the 1996 calendar year. We would like you, as the addressee, to fill out the questionnaire.

Your answers to the following questions will help us understand more about 1996 New York anglers, their fishing, and their opinions and preferences about several fishing topics. The New York State Department of Environmental Conservation will use the information you and others provide to set the course for future fisheries management in the State. <u>Your answers are important.</u>

THANK YOU FOR YOUR COOPERATION

Printed on recycled paper

1996 NEW YORK STATEWIDE FRESHWATER FISHING SURVEY

1. Did you go freshwater fishing in New York between January 1 and December 31, 1996?

0 No **(PLEASE SKIP TO QUESTION 16)**

1 Yes **(CONTINUE WITH QUESTION 2)**

FISHING PREFERENCES

2. New York State has a wide variety of waters, fish species, and anglers. Complex regulations provide the Department of Environmental Conservation (DEC) the greatest flexibility to manage individual species in specific waters. However, complex regulations make the fishing guide longer and harder for many anglers to understand. On a scale of 1 to 7, where 1 = simple regulations but least variety of fishing opportunities and 7 = complex regulations but greatest variety of fishing opportunities, how complex do you think DEC fishing regulations should be in New York State? *(Circle one number.)*

Simple Regulations but Least Variety — Complex Regulations but Greatest Variety

1 2 3 4 5 6 7

3. New York allows some panfish (e.g. yellow perch, bluegill, bullheads) that are caught by hook and line to be sold legally. Some people are concerned about possible over-harvest of larger panfish, particularly on some smaller inland waters. To address these concerns, DEC developed new regulations such as minimum size and creel limits on crappie (thus making them illegal to sell) and limits of 50 sunfish and 50 yellow perch (still saleable) over much of the state. Do you feel DEC's response to this concern was: *(Check one.)*

1 Appropriate

2 Unfair: the new regulations should be eliminated and the sale of hook and line panfish should be banned rather than placing restrictions on all anglers

3 Too strict: the new regulations should be eliminated and the sale of panfish caught by hook and line should be allowed

4 Not strict enough: in addition to the new regulations, the sale of hook and line-caught panfish should be banned

5 No opinion

4. The opening day of trout season in New York has traditionally been April 1 regardless of the day of the week. Would you prefer the trout season opening day to be on: *(Check one.)*

- __1__ A WEEKEND day in March
- __2__ A WEEK DAY in March
- __3__ April 1, regardless of the day of week
- __5__ The first WEEKEND day in April
- __6__ The first WEEK DAY in April
- __7__ A later WEEKEND day in April
- __8__ A later WEEK DAY in April
- __4__ No preference for when trout season opens in New York

FISHERIES MANAGEMENT

5. Please indicate how strongly you support each of the following potential fishery management actions in New York State, regardless of whether you would be affected: *(Circle one number for each item.)*

		No Support				Strong Support
Y4	a. Protecting fish spawning and nursery areas.	1	2	3	4	5
Y5	b. Using daily bag limits to more fairly distribute fish catch among anglers.	1	2	3	4	5
Y6	c. Using closed seasons and size limits to assure successful fish spawning.	1	2	3	4	5
Y7	d. Using size limits to maintain or improve fishing quality.	1	2	3	4	5
Y8	e. Using tackle restrictions to improve fishing quality.	1	2	3	4	5
Y9	f. Stocking trout in streams.	1	2	3	4	5
Y10	g. Maintaining walleye fisheries through stocking.	1	2	3	4	5
Y11	h. Developing areas on lakes and rivers for shore fishing.	1	2	3	4	5
Y12	i. Increasing boat access to lakes, ponds, and rivers.	1	2	3	4	5
Y13	j. Increasing public access to trout streams.	1	2	3	4	5
Y14	k. Conducting fishing clinics for children and parents.	1	2	3	4	5
Y15	l. Protecting endangered fish and aquatic species.	1	2	3	4	5
Y16	m. Restoring native species like Atlantic salmon and sturgeon.	1	2	3	4	5
Y17	n. Increasing fishing opportunities for the handicapped.	1	2	3	4	5
Y18	o. Stocking trout in urban ponds to provide seasonal fishing.	1	2	3	4	5
Y19	p. Maintaining brook trout fishing in remote Catskill and Adirondack ponds.	1	2	3	4	5
Y20	q. Managing some waters for catch and release fishing.	1	2	3	4	5
Y21	r. Maintaining a native muskellunge fishery.	1	2	3	4	5
Y22	s. Protecting fish habitat in streams and shallow waters of lakes and rivers from bulldozing and/or filling.	1	2	3	4	5
Y23	t. Strictly enforcing fishing laws and regulations.	1	2	3	4	5
Y24	u. Providing information on where to fish, fish identification, and fish habits.	1	2	3	4	5
Y25	v. Providing information on fishing seasons, daily limits, and legal sizes.	1	2	3	4	5
Y26	w. Providing docks and piers from which to fish.	1	2	3	4	5

		No Support				Strong Support
Y27	x. Informing anglers about fish consumption advisories and where contaminants may pose a threat to human health.	1	2	3	4	5
Y28	y. Maintaining fishing for large trout and salmon on large lakes such as Erie, Ontario, Champlain and the Finger Lakes.	1	2	3	4	5
Y29	z. Strictly enforcing laws protecting water quality.	1	2	3	4	5

CHILDREN'S FISHING NEEDS

6. How many children under age 16 are in your household?

9 = nothing written here, but Q8 & Q9 filled out

Y30 0-8 ___ Number of children **(IF ZERO, PLEASE SKIP TO QUESTION 10)**

7. How many of these children went fishing at least 2 times in the past year?

9 = nothing written here, but Q8 & Q9 filled out

Y31 0-8 ___ Number of children **(IF ZERO, PLEASE SKIP TO QUESTION 9)**

8. When your children go fishing, who do they go with? *(Check all that apply.)*

0 = not checked
1 = checked

Y32 _____ One or more of their friends

Y33 _____ Their parent or guardian

Y34 _____ With an organized youth group

Y35 _____ Brothers, sisters, or cousins

Y36 _____ An adult relative or friend

Y37 _____ By themselves

9. Think about why your oldest child (under age 16) did not go fishing more often last year. How important do you think each of the reasons below are for explaining why they didn't fish more often last year? *(Circle one number for each item.)*

		Not Important				Extremely Important
Y38	a. Doesn't have the skills needed to fish	1	2	3	4	5
Y39	b. Prefers other activities more	1	2	3	4	5
Y40	c. Has never tried fishing	1	2	3	4	5
Y41	d. No suitable fishing sites nearby	1	2	3	4	5
Y42	e. Doesn't have the necessary equipment	1	2	3	4	5
Y43	f. Doesn't have friends who enjoy fishing	1	2	3	4	5
Y44	g. Doesn't have an adult who is able to take him or her fishing	1	2	3	4	5
Y45	h. Can't afford the equipment needed	1	2	3	4	5
Y46	i. Not old enough to go fishing	1	2	3	4	5
Y47	j. Has too much school work	1	2	3	4	5
Y48	k. Has a job that keeps him or her too busy	1	2	3	4	5

10. FISHING LOCATION AND EXPENSE TABLE.

Please answer the questions below about all your freshwater fishing IN NEW YORK FROM JANUARY 1 to DECEMBER 31, 1996. Since we are only interested in totals for each location, please list each location only once. Include only the fishing you personally did or the dollars you personally spent.

WHERE DID YOU FISH IN NEW YORK?				HOW MANY TRIPS DID YOU TAKE AND HOW MANY TOTAL DAYS DID YOU FISH AT EACH LOCATION?			
LOCATION	NAME OF STREAM OR LAKE	COUNTY OR NEAREST POST OFFICE	APPROXI-MATE MILEAGE FROM YOUR HOME (ONE WAY)	NUMBER OF TRIPS	NUMBER OF DAYS	Yellow Perch	Walleye (Yellow Pike)
EXAMPLE	Indian Lake	Hamilton	90	4	8	P	W
1							
2							
3							
4							
5							
6							
7							
8							

ON HOW MANY OF THOSE DAYS WERE YOU FISHING PRIMARILY FOR THE FOLLOWING TYPES OF FISH? (Your total for each location should equal the number of days fished in the preceding column)													HOW MUCH DID YOU SPEND FOR ALL TRIPS TO EACH LOCATION? (Gas and oil, food, lodging, boat rental, tackle, bait, etc.)		HOW WOULD YOU RATE THIS LOCATION?	HOW WOULD YOU RATE YOUR SATISFACTION WITH TRIPS TO THIS LOCATION IN 1996?
Days Fished For:																
Bluegill / Sunfish	Crappie / Calico Bass	Northern Pike	Muskie	Lake Trout	Rainbow / Steelhead Trout	Brown Trout	Coho or Chinook Salmon	Atlantic / Landlocked Salmon	Brook Trout	Bullheads / Catfish	Other	No Specific Type	TOTAL SPENT AT EACH LOCATION	TOTAL SPENT WHILE TRAVELING TO AND FROM EACH FISHING LOCATION	On a scale of 1 to 7 where: 1=a common or ordinary fishing site and 7=a special or unique fishing site	On a scale of 1 to 7 where: 1=very dissatisfied, 4=neutral, and 7=very satisfied
P	P	W	W	2	C	C	C	C	C	P		2	$ 175	$45	5	4

ABOUT THE VALUE OF YOUR FISHING

The information that you provide in Question 11 will help us develop estimates of economic values of New York's fisheries resources.

To answer Q11, please focus on a particular 1996 fishing trip to the location and waterway that you told us about on Line 2 of the previous question (Q10). Refer back to Q10 and note the location that you listed on Line 2. If you took more than 1 trip to that location in 1996, try to focus on the last trip you took. (If you only fished one location in 1996, please answer the following questions with regard to the location you listed on Line 1.)

11a. How many days did you fish on this trip?

99 = some amount, but not a number

49 0-98____ Number of days

b. Approximately how much did you spend for YOUR SHARE of the total expenses for this trip (gas/oil, food, lodging, rentals, bait, etc.)? *(Do not include any major items of fishing equipment that you may have purchased.)*

Y50 $ 0 - 9,998 9999 = some amount, but not a number

c. Now suppose the costs of this trip had been substantially higher. This could have been because of a sudden increase in the price of gasoline, food and lodging, or any other expense items. If your total cost for this trip had been 3 times what you actually spent, would you still have taken this fishing trip?

Y51

__0__ No (SKIP TO Q11e)

__1__ Yes (GO ON TO Q11d)

d. If the total cost of this trip had been 4 times what you paid, would you still have taken this trip?

Y52

__0__ No (SKIP TO Q11f)

__1__ Yes (SKIP TO Q11f)

e. If the total cost of this trip had been 2 times what you paid, would you still have taken this trip?

Y53

__0__ No

__1__ Yes

f. What is the MAXIMUM total amount you would have been willing to pay for this fishing trip before you would have decided not to go?

0 - 99,998 99,999 = some amount, but not a number

Y54 $ _______ MAXIMUM total cost you would have paid

ICE FISHING

12. Did you do any ice fishing in New York from January 1 to December 31, 1996?

_0_ No **(SKIP TO QUESTION 14)**

_1_ Yes **(CONTINUE)**

If nothing is checked here, but Q13 is filled out - assume Y55 = 1

13. Ice fishing location and expense table. Please answer the questions below about all your ice fishing trips in New York from January 1, 1996 to December 31, 1996. (Include all ice fishing information you reported in Question 10.)

WHERE DID YOU *ICE FISH* IN NEW YORK?		HOW MANY TRIPS DID YOU TAKE AND HOW MANY TOTAL DAYS DID YOU FISH AT EACH LOCATION?		HOW MUCH DID YOU SPEND FOR **ALL** TRIPS TO EACH LOCATION? (Gas and oil, food, lodging, tip-ups, bait, etc.)	
NAME OF LAKE OR RIVER	COUNTY OR NEAREST POST OFFICE	NUMBER OF TRIPS	NUMBER OF DAYS	TOTAL SPENT AT EACH LOCATION	TOTAL SPENT WHILE TRAVELING TO AND FROM EACH LOCATION
Y56 (3 col.) use same list as center page	Y57 (2 col.) use same list as center page	Y58 (3 col.)	Y59 (3 col.)	Y60 (5 col.)	Y61 (5 col.)
Y62	Y63	Y64	Y65	Y66	Y67
Y68	Y69	Y70	Y71	Y72	Y73
Y74	Y75	Y76	Y77	Y78	Y79
Y80	Y81	Y82	Y83	Y84	Y85

FISHING SKILL

14. Please circle the number below that best indicates your overall fishing skill. This includes using fishing equipment that is specialized for particular types of fishing, locating fish, and catching fish.

Novice; Unskilled			Somewhat Skilled			Very Highly Skilled
1	2	3	4	5	6	7

FISHING ACCESS NEEDS

15. On what waterway in New York would you most like to see access for fishing increased?

Waterway: Y86 (3 col.) use same list as center page ______ In County: Y87 (2 col.) use same list as center page

For what type of fishing and fish species on this waterway should access be increased? *(Check all that apply.)*

	Fishing Type		Fish Species
Y88 0 = not checked 1 = checked	By motorized boat	Y93 0 = not checked 1 = checked	Trout or salmon
Y89 ______	By unmotorized boat	Y94 ______	Walleye or pike
Y90 ______	From shore or a pier	Y95 ______	Panfish
Y91 ______	By wading	Y96 ______	Yellow perch
Y92 ______	Through the ice	Y97 ______	Bass or crappie

The following information will help us categorize fishing participation in New York and predict future interest in fishing. All information is kept strictly confidential and is never associated with your name.

16. How many years have you fished on a fairly regular basis (at least 2 days per year)? 0 = 0 years
98 = some amount, but not a number

203 1-97 Number of years fishing regularly

0 Check here if you have only fished occasionally in the past (less than 2 days per year)

17. In approximately what year did you buy your FIRST New York fishing license?

98 19 (2 col.) 0-96 99 = some amount, but not a number

18. Which of the following best describes the area where you lived most of the time before age 16? *(Check one.)*

1 Rural, hamlet, or village (under 5,000 population)

1204 2 Small city of 5,000 to 24,999 population

3 City of 25,000 to 99,999 population

4 Large city of 100,000 population or over

19. Are you presently a member of a fish and game club or an organized sportsman's group?

37 __0__ No
__1__ Yes

20. What is your race?

__1__ White
__2__ Black or African-American
5 __3__ Asian or Pacific Islander
__4__ Native American Indian
__5__ Other

21. Are you of Spanish or Hispanic origin?

__0__ No
__1__ Yes

22. Please circle your approximate 1996 TOTAL HOUSEHOLD INCOME before taxes, in thousands of dollars:

Less than 10	10	12	14	16	18	20	22	24	26	28		
30	32	34	36	38	40	45	50	55	60	65	70	
75	80	85	90	95	More than 95							

96

Normally, Cornell University never associates your name with the information you provide. However, it would be extremely valuable to state fisheries managers to be able to contact a sample of anglers for updated information about specific waterways or fishing preferences. If such information is needed in the future, may Cornell University or the DEC, Bureau of Fisheries contact you for further information? (Other information such as your race or income would still be kept confidential and not associated with your name.)

__0__ No
__1__ Yes

Please use the space on the back of this questionnaire for any comments you wish to make.

10 → look for comments on back

THANK YOU FOR YOUR TIME AND EFFORT!

To return this questionnaire, simply place it in the enclosed, self-addressed envelope; postage has been provided.

Appendix B: Calculation to Account for Nonresponse Bias

From the original sample of 17,000, 822 were undeliverable, 8,760 responded, and the rest (7,418) were nonrespondents. From the nonrespondents, 1,011 were interviewed by telephone. We assume (and checks of region of license purchase and license type confirm our assumption) that those interviewed by telephone are representative of all nonrespondents. Undeliverable surveys will be dropped from the analysis here because we know nothing specific about their fishing behavior and we assume that they are similar to the general angling public.

The following data compared respondents and nonrespondents (expanded from the telephone survey):

	Percent	n	Mean number of days fished	Total days
Respondents	100.0	8,760		
Who fished	87.0	7,621	23.0	175,283
Who did not fish	13.0	1,139	0	0
Nonrespondents	100.0	7,418		
Who fished	79.2	5,875	18.6	109,275
Who did not fish	20.8	1,543	0	0
Total		16,178		284,558

If we sum the number of respondents and nonrespondents who fished (7,621 + 5,875 = 13,496) and divide by the total (13,496 ÷ 16,178) we see that 83.4% of the survey audience fished. To find the number of license buyers who fished, we multiply 83.4% x 1,057,337 license purchasers resulting in 881,819 people who fished. This number is used as the base for all estimates of the number of anglers fishing various locations in New York.

To calculate the number of days fished the following calculation was solved for x:

$$\frac{13{,}496 \text{ sample that fished}}{284{,}558 \text{ days fished}} = \frac{7{,}621 \text{ respondents that fished}}{x \text{ days fished}}$$

x = 160,686 days. If respondents were representative of all anglers they would have fished 160,686 days, but instead they fished 175,283. Therefore the number of days should be weighted by .917 (160,686 ÷ 175,283). All estimates of days fished were weighted by this number (accounting for nonresponse bias) then mean days fished were expanded to the population by multiplying by the number of anglers at that location. Estimates of the number of trips were weighted and expanded similarly. Expenditures were calculated on a cost per day basis then expanded using the estimated number of days fished.

For the Great Lakes survey, a sample of 5,000 names was drawn using the same criteria as for the statewide angler survey. However, the sample for the Great Lakes study was stratified by county of license purchase, allowing a larger sample to be drawn from counties bordering the Great Lakes, resulting in a larger number of anglers with interest in Great Lakes fishing. Respondent data were then weighted using county of license purchase to estimate effort and expenditures on a statewide basis.

Of the 5,000 questionnaires mailed, 222 were undeliverable and 2,780 completed questionnaires were returned. This resulted in an adjusted response rate of 58.2%. A copy of the questions used in estimating effort and expenditures is included at the end of this appendix. Nonrespondent phone follow-up interviews were conducted with 100 nonrespondents. Nonrespondents were less likely to have fished the Great Lakes or the St. Lawrence River in 1996 than respondents (27.5% versus 44.7%). Estimates of the number of anglers fishing a waterway were adjusted for this nonresponse bias before being combined with statewide angler data.

Estimates of days fished were adjusted for nonresponse bias in the statewide angler survey by multiplying days by the factor 0.917. We assumed a similar nonresponse bias existed in the Great Lakes data but could not adjust for it using the Great Lakes nonrespondent survey due to insufficient sample sizes. Therefore, we used the same adjustment factor (0.917) as the statewide survey for Great Lakes data when adjusting days of fishing effort for nonresponse bias before combining the data with statewide angler data.

Estimated expenditures from the Great Lakes study were calculated the same way as for the statewide survey with one exception. The Great Lakes data could not be weighted for the item response bias associated with distance traveled to the fishing site because distance traveled was not ascertained in the Great Lakes survey.

Estimates derived from the statewide database were compared with estimates from the combined dataset for the major Great Lakes waterways and the St. Lawrence River. Since the methods used to obtain the data were quite similar, we would expect the estimates to be similar. In fact, most estimates were similar (e.g., Lake Erie anglers estimated from statewide data = 59,520 versus 63,020 estimated from the combined data). One exception was the estimated number of anglers fishing Lake Ontario (164,360 from statewide data versus 188,210 from combined data). Possible explanations for the general differences include: (1) the Great Lakes survey listed the major Great Lakes waterways, prompting respondent recall, whereas in the statewide survey respondents had to write down each waterway fished; and (2) in the statewide survey if the respondent recorded only the county fished or did not clearly identify the waterway fished, that fishing effort could not be properly attributed to a specific waterway. Other possible additional explanations for the differences in estimated numbers of Lake Ontario anglers include the following. First, duplicate reporting of effort by Great Lakes survey respondents may have occurred if respondents reported Salmon River fishing under Lake Ontario because Lake Ontario was listed first, then reported the same effort under the Salmon River. Second, in the Great Lakes survey, Lake Ontario was broken down into sections and counties associated with each section were listed, possibly resulting in reporting of fishing effort on other waterways in addition to Lake Ontario fishing for the counties listed.

The effect of these differences in method could result in both overestimates and underestimates of fishing effort. Thus, we chose to combine the data from the two studies as described above to provide our best estimates of Great Lakes fishing effort and expenditures. However, when trend data are discussed, we have chosen to report estimates from the statewide data only for comparability with past studies.

References

Alexander, S., Ehrlich, P. R., Goulder, L., Lubchenco, J., Matson, P. A., Mooney, H. A., ... & Woodwell, G. M. (1997). *Ecosystem services: benefits supplied to human societies by natural ecosystems* (Vol. 2). Washington (DC): Ecological Society of America.

Adamowicz, W., Louviere, J., & Swait, J. (1998). Introduction to attribute-based stated choice methods. *NOAA-National Oceanic Athmospheric Administration, Washington, USA,*

Alberini, A., & Kahn, J. R. (Eds.). (2009). Handbook on contingent valuation. Edward Elgar Publishing.

American Automobile Association, Your Driving Costs (Heathrow, FL: Annual Issues)

Ahlheima, M., & Buchholzb, W. (2000). WTP or WTA-is that the question?

Brown, T. L., & Wilkins, B. T. (1978). Clues to reasons for nonresponse and its effect upon variable estimates. Journal of Leisure Research, 10(3), 226-231.

Bockstael, N. E., Hanemann, W. M., & Kling, C. L. (1987). Estimating the value of water quality improvements in a recreational demand framework. *Water Resources Research, 23*(5), 951-960. doi:10.1029/WR023i005p00951

Bishop, R. C., & Heberlein, T. A. (1979). Measuring values of extramarket goods: Are indirect measures biased?. American journal of agricultural economics, 61(5), 926 930.

Boxall, P. C., Adamowicz, W. L., Swait, J., Williams, M., & Louviere, J. (1996). A comparison of stated preference methods for environmental valuation. *Ecological* Economics, 18(3), 243-253. doi:10.1016/0921-8009(96)00039-0

Brown, G. M., & Hay, M. J. (1987). Net economic recreation values for deer and waterfowl hunting and trout fishing, 1980. Division of Policy Directives Management, US Fish and Wildlife Servive.

Ciriacy-Wantrup, S. V. (1947). Capital returns from soil-conservation practices.*Journal of farm economics*, *29*(4 Part II), 1181-1196.

Cicchetti, C. J., Fisher, A. C., & Smith, V. K. (1976). An econometric evaluation of a generalized consumer surplus measure: the mineral king controversy.*Econometrica: Journal of the Econometric Society*, 1259-1276.

Connelly, N. A., T. L. Brown, and B. A. Knuth. 1990. New York statewide angler survey 1988. New York State Department of Environmental Conservation, Bureau of Fisheries, Albany

Carson, R. T. (2000). Contingent valuation: A user's guide. *Environmental Science & Technology*, *34*(8), 1413-1418.

Chavez-Comparan, J. C., & Fischer, D. W. (2001). Economic valuation of the benefits of recreational fisheries in Manzanillo, Colima, Mexico. Tourism Economics, 7(4), 331 345.

Carson, R. T., Flores, N. E., Martin, K. M., & Wright, J. L. (1996). Contingent valuation and revealed preference methodologies: Comparing the estimates for quasi-public goods. *Land Economics, 72*(1), 80-99.

Casey, J. F. (1995). The economic value of hiking. *Journal of Agricultural and Applied Economics, 27*(2), 658-668.

Clawson, M., 1905-1998. (1959). *Methods of measuring the demand for and value of outdoor recreation.* Washington,: Resources for the Future,.

Clawson, M., 1905-1998. (1966). *Economics of outdoor recreation,.* Baltimore,: Published for Resources for the Future by Johns Hopkins Press.

Costanza, R., Farber, S. C., Maxwell, J. Valuation and Management of Wetland Ecosystems. Elsevier Science Publishers, Ecological Economics, 1 (1989) 335-361.

Connelly, N., Brown, T. L., & Knuth, B. A. (1997). *New york statewide angler survey, 1996* New York State Department of Environmental Conservation, Division of Fish and Wildlife.

Cameron, T.A., (1992, August). Combining Contingent Valuation and Travel Cost Data for the Valuation of Nonmarket Goods. The University of Wisconsin Press, Land Economics, Vol. 68, pp. 302-317

Coursey, D. L., Hovis, J. L., & Schulze, W. D. (1987). The disparity between willingness to accept and willingness to pay measures of value. *The Quarterly Journal of Economics*, *102*(3), 679-690.

Clarke, P. M. (2002). Testing the convergent validity of the contingent valuation and travel cost methods in valuing the benefits of health care. Health economics, 11(2), 117 127.

Champ, P.A., Boyle, K.J., & Brown, T.C (2005). A primer on nonmarket valuation. (volume 3), London: Kluwer Academic Publishers.

Davis, R. K. (1963). *The value of outdoor recreation: an economic study of the Maine Woods* (Doctoral dissertation, Harvard University.)

Donnelly, Dennis M., John B. Loomis, Cindy F. Sorg, and Louis J. Nelson. 1985. Net Economic Value of Recreational Steelhead Fishing in Idaho. Resource Bulletin RM-9. Fort Collins, CO: U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

Duffield, John W., and Stewart Allen. 1988."Contingent Valuation of Montana Trout Fishing by River and Angler Subgroup." Final Economic Report prepared for the

Montana Department of Fish, Wildlife, and Parks. Helena: Montana Department of Fish, Wildlife, and Parks, September.

Diamond, P. A., & Hausman, J. A. (1994). Contingent valuation: is some number better than no number?. The Journal of economic perspectives, 45-64.

Dryzek, J. S. (1994). Discursive democracy: Politics, policy, and political science. Cambridge University Press.

De-Corla-Souza, P., Issues Relating to Use of Travel Models in Benefit-Cost Analysis. Paper No. 99-0214

Douglas, A. J., & Taylor, J. G. (1998). A new model for the travel cost method: The total expenses approach. *Environmental Modelling & Software, 14*(1), 81-92. doi:10.1016/S1364-8152(98)00060-7

Fedkiw, J. (1987). Coming Back to Market Value and Valuation for the Great Lakes Fisheries. Transactions of the American Fisheries Society, 116:3, 346-351

Font, A. R. (2000). Mass tourism and the demand for protected natural areas: A travel cost approach. *Journal of Environmental Economics and Management, 39*(1), 97-116. doi:http://dx.doi.org/10.1006/jeem.1999.1094

Gordon, D., Chapman, D. W., & Bjornn, T. C. (1973). Economic Evaluation of Sport Fisheries—What Do They Mean?. *Transactions of the American Fisheries Society*, *102*(2), 293-311.

Glass, R. J., Muth, R. M., (2011, January 9). Pitfalls and Limitations in the Use of Fishery Valuation Techniques. Transactions of the American Fisheries Society, 116:3, 381-389.

George R. Parsons. , Kang, Ami K. Leggett, Christopher G., Boyle, Kevin J. (2009-10-28). **Valuing beach closures on the padre island national seashore**. *Marine Resource Economics, Vol. 24 No. 3*, 213-235.

Gil-Moltó, M. J., & Hole, A. R. (2004). Tests for the consistency of three-level nested logit models with utility maximization. *Economics Letters, 85*(1), 133-137.

Groothuis, P. A. (2005). Benefit transfer: A comparison of approaches. *Growth & Change, 36*(4), 551-564. doi:10.1111/j.1468-2257.2005.00294.x

Harris, C. C. (1983). Assessing the validity of economic methods for evaluating sport fishery benefits: a behavioural approach. Dissertation Abstracts International, A, 44(2).

Hotelling, H. 1949. "Letter." In An Economic Study of the Monetary Evaluation of Recreation in the National Parks. Washington, DC: National Park Service.

Hanemann, W. M. (1991). Willingness to pay and willingness to accept: How much can they differ? *The American Economic Review, 81*(3), 635-647.

Hanemann, W. M. (1994). Valuing the environment through contingent valuation. *The Journal of Economic Perspectives, 8*(4), 19-43.

Hausman, J. A., Leonard, G. K., & McFadden, D. (1995). A utility-consistent, combined discrete choice and count data model assessing recreational use losses due to natural resource damage. *Journal of Public Economics*, *56*(1), 1-30. doi:10.1016/0047-2727(93)01415-7

Hoehn, J. P., Tomasi, T., Lupi, F., & Chen, H. Z. (1996). An economic model for valuing recreational angling resources in michigan. *Michigan State University, Report to the Michigan Department of Environmental Quality,*

Heiss, F., (2002, January 4). Specification (s) of Nested Logit Model.

Haefele, M. A., Loomis, J. B. Year of Publication. A Comparison of Conjoint Ratings and Rankings: An Application for Passive Use Values of Forest Health. Presented at *Western Agricultural Economics Association Annual Meeting, July 11-14, 1999, Fargo, ND*

Jaroszewski, L. M., 1974-. (2000). *Using a land allocation model to assess the welfare economic implications of new york state's conservation reserve enhancement program*

Johnson, D. M. (1989). Economic benefits of alternative fishery management programs (Doctoral dissertation, Colorado State University).

Jeon, Y., & Herriges, J. A. (2010). Convergent validity of contingent behavior responses in models of recreation demand. *Environmental and Resource Economics, 45*(2), 223-250.

Jacobs, M. (1997)‘Environmental Valuation, Deliberative Democracy and Public Decision-Making Institutions’. In J. Foster (ed), Valuing Nature? Economics, Ethics, Environment. London: Routledge, 1997, pp211-231.

Knetsch, J. L. (1963). Outdoor recreation demands and benefits. LAND ECONOMICS, VOL 39, NO 4, 1963, PP 387-396.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. Econometrica: Journal of the Econometric Society, 263-291.

Knight, R.L. & Bates, S.F.(1995). A new century for natural resource management. Washington D.C: Island Press

Kahn, R.J. (1997). The economic approach to environmental and natural resources. (2nd Edition), Dryden Press

Loomis, J., Sorg, C., & Nelson, L. (1985). Net economic value of recreational steelhead fishing in Idaho. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Loomis, J. B., Sorg, C. F., & Donnelly, D. M. (1986). Evaluating regional demand models for estimating recreation use and economic benefits: A case study. Water Resources Research, 22(4), 431-438.

Loomis, J., Creel, M., & Park, T. (1991). Comparing benefit estimates from travel cost and contingent valuation using confidence intervals for hicksian welfare measures. Applied Economics, 23(11), 1725-1731.

Loomis, J. (2006). A comparison of the effect of multiple destination trips on recreation benefits as estimated by travel cost and contingent valuation methods. Journal of Leisure Research, 38(1), 46-60.

Loomis, J., & Ng, K. (2012). Comparing economic values of trout anglers and nontrout anglers in Colorado's stocked public reservoirs. North American Journal of Fisheries Management, 32(2), 202-210.

Mitchell, R. C., & Carson, R. T. (1986). use of contingent valuation data for benefit/cost analysis in water pollution control.

Montgomery, M., & Needelman, M. (1997). The welfare effects of toxic contamination in freshwater fish. Land Economics, 73(2), 211-223.

Northwest, E. C. O. (1984). Economic Valuation of Potential Losses of Fish Populations in the Swan River Drainage. Final report prepared for the Montana Department of Fish, Wildlife, and Parks. Seattle, September.

Navrud, S. (Ed.). (1992). Pricing the European environment. Oslo, Norway: Scandinavian University Press.

"New York Map Collection." Map of New York. N.p., n.d. Web. 06 Jan. 2014. from http://geology.com/state-map/new-york.shtml

Parsons, G. R., & Kealy, M. J. (1992). Randomly drawn opportunity sets in a random utility model of lake recreation. *Land Economics*, *68*(1), 93-106.

Poe, G. L., Severance-Lossin, E. K., & Welsh, M. P. (1994). Measuring the difference (X—Y) of simulated distributions: A convolutions approach. *American Journal of Agricultural Economics*, *76*(4), 904-915.

Poe, G. L., Clark, J. E., Rondeau, D., & Schulze, W. D. (2002). Provision point mechanisms and field validity tests of contingent valuation. *Environmental and Resource Economics*, *23*(1), 105-131.

Poe, G.L., Giraud, K.L. and Loomis, J.B. (2005). Computational methods for measuring the differences of empirical distributions, American Journal of Agricultural Economics 87(2), 353–365.

Phaneuf, D. J., & Smith, V. K. (2005). Recreation demand models. *Handbook of environmental economics*, *2*, 671-761.

Parsons, G. R., Jakus, P. M., & Tomasi, T. (1999). A comparison of welfare estimates from four models for linking seasonal recreational trips to multinomial logit models of site choice. Journal of Environmental Economics and Management, 38(2), 143-157. doi:10.1006/jeem.1999.1083

Randall, A. (1994). A difficulty with the travel cost method. Land Economics, 70(1), 88-96.

Rowe, D. C., Linver, M. R., & Rodgers, J. L. (1996). *Delinquency and IQ: Using siblings to find sources of variation*. Ablex Publishing.

Rolfe, J., & Dyack, B. (2010). Testing for convergent validity between travel cost and contingent valuation estimates of recreation values in the Coorong, Australia*. Australian Journal of Agricultural and Resource Economics, 54(4), 583-599.

Ready, R. C., Poe, G. L., Lauber, T. B., Creamer, S., Connelly, N. A., & Stedman, R. C. (2012). Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins.

Smith, C. J., DeLaune, R. D., & Patrick Jr, W. H. (1983). Carbon dioxide emission and carbon accumulation in coastal wetlands. *Estuarine, coastal and shelf science*, *17*(1), 21-29.

Sorg, C. F., & Loomis, J. B. (1984). Empirical estimates of amenity forest values: a comparative review. General Technical Report, Rocky Mountain Forest and Range Experiment Station, USDA Forest Service, (RM-107).

Sorg, C. F., & Loomis, J. B. (1986). Economic value of Idaho sport fisheries with an update on valuation techniques. North American Journal of Fisheries Management, 6(4), 494-503.

Seller, C., Stoll, J. R., & Chavas, J. P. (1985). Validation of empirical measures of welfare change: a comparison of nonmarket techniques. Land Economics,61(2), 156 175.

Smith, V. K., Desvousges, W. H., & Fisher, A. (1986). A comparison of direct and indirect methods for estimating environmental benefits. American Journal of Agricultural Economics, 68(2), 280-290.

Sagoff, M. (1988). The economy of the earth: Philosophy, law and the environment. Cambridge University Press.

Smith, V. K., & Kaoru, Y. (1990). What have we learned since hotelling's letter?: A meta-analysis. Economics Letters, 32(3), 267-272. doi:http://dx.doi.org/10.1016/0165-1765(90)90110-M

Spink, E., 2014. "The Effect of Temporal Specificity on Welfare Estimates in a Travel Cost Recreational Demand Model: Evidence From New York State Angler Participation." Unpublished Master's Thesis, Cornell University.

Train, K. (2009). Discrete choice methods with simulation Cambridge university press.

U.S. Water Resources Council. 1979. Procedures for evaluation of National Economic Development (NED) benefits and costs in water resources planning. Federal Register 44(242):72892-72976.

U.S. Water Resources Council. 1983. Economic and environmental principles for water and related land resourcesim plementation studies.F ederal Register 184(48): 1-37.

Vaughan, W. J., & Russell, C. S. (1982). Valuing a fishing day: An application of a systematic varying parameter model. Land Economics, 450-463.

Varian, H. R. (2006). The economics of internet search. Rivista di politica economica, 96(11/12), 8.

Williams, J. S., & Bettoli, P. W. (2003). Net value of trout fishing opportunities in Tennessee tailwaters. Fisheries Report, (03-21).

Wegge, T. C., Hanemann, W. M., & Strand, I. E. (1986). An economic assessment of marine recreational fishing in Southern California. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Region.

Ward, F. A., & Loomis, J. B. (1986). The travel cost demand model as an environmental policy assessment tool: A review of literature. Western Journal of Agricultural Economics, 11(2), 164-178.

Willis, K. G. (1990). Valuing non-market wildlife commodities: an evaluation and comparison of benefits and costs. Applied economics, 22(1), 13-30.

Whitehead, J. C. (2006). A comparison of contingent valuation method and random utility model estimates of the value of avoiding reductions in king mackerel bag limits. Applied Economics, 38(15), 1725-1735.

Whitehead, J. C., Groothuis, P. A., Southwick, R., & Foster-Turley, P. (2009). Measuring the economic benefits of Saginaw Bay coastal marsh with revealed and stated preference methods. Journal of Great Lakes Research, 35(3), 430-437.

Whitehead, J. C., Phaneuf, D. J., Dumas, C. F., Herstine, J., Hill, J., & Buerger, B. (2010). Convergent validity of revealed and stated recreation behavior with quality change: A comparison of multiple and single site demands. Environmental and Resource Economics, 45(1), 91-112.

Whitehead, J. C. (2006). A comparison of contingent valuation method and random utility model estimates of the value of avoiding reductions in king mackerel bag limits. Applied Economics, 38(15), 1725-1735. doi:10.1080/00036840500427130

Williams, M. (1994). Combining revealed and stated preference methods for valuing environmental amenities. Journal of Environmental Economics and Management, 26, 271-292.